1985 ANNUAL REPORT

to the

GOVERNMENTS OF CANADA, UNITED STATES,

SASKATCHEWAN AND MONTANA

by the

POPLAR RIVER BILATERAL MONITORING COMMITTEE

Covering Calendar Year 1985

May, 1986

LETTER OF TRANSMITTAL

TO:

Department of State
Washington, D.C., United States

Department of External Affairs
Ottawa, Ontario, Canada

Governor's Office, State of Montana
Helena, Montana, United States

Saskatchewan Environment
Regina, Saskatchewan, Canada

Gentlemen:

During 1985, the Poplar River Bilateral Monitoring Committee continued to fulfill the responsibilities assigned by the governments under the Poplar River Cooperative Monitoring Arrangement dated September 23, 1980. Water quantity, water quality, and air quality relevant to the International Boundary were monitored in accordance to the 1985 Technical Monitoring Schedule. The monitoring data were exchanged on a quarterly basis. Herein is the report of activities of 1985 and the proposed monitoring schedule for 1986.

The report summarizes current conditions relative to pre-project conditions and compares current conditions to guidelines for specific parameter values that were developed under International Joint Commission references. References are made to State, Provincial, or Federal standards or objectives where these are relevant. After examination and evaluation of the monitoring information for 1985, the Committee finds that the measured conditions are within the norms of the accepted objectives.

The Committee was advised that Saskatchewan Environment has required the developers of the new coal mines, 10 to 15 kilometres east of the present mine, to conduct an environmental impact study. The study will address the question of dewatering effects and will be available for public review during 1987.

In September 1985 the initial five-year term of the Cooperative Monitoring Arrangement expired. In accordance with Article 5 the parties agreed to a one-year extension. It is respectfully suggested that the arrangement be extended for a further five-year period or until such time as governments have finalized arrangements for another body to monitor developments in the Poplar River Basin.

Yours sincerely,

J. R. Knapton
Chairman, United States Section

G. W. Howard
Acting Chairman, Canadian Section

R. E. Driear
Member, United States Section

W. D. Gummer
Member, Canadian Section

POPLAR RIVER BILATERAL MONITORING COMMITTEE

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1985 HIGHLIGHTS

1985 was the second full year of operation for two 300 megawatt coal-fired units. Over 4,560,700 gross megawatt hours of electricity were generated. The number of start-ups was down to 21 compared to 29 in 1984 and a high of 58 in 1983. As a result the consumption of oil fell to 2,743 tonnes, compared to 3,700 tonnes in 1984 and 13,756 tonnes in 1983.

Monitoring information collected in both Canada and the United States was exchanged on a quarterly basis. In general the sampling locations, frequency of collection, and parameters met the requirements identified in the Technical Monitoring Schedules. Air quality monitoring in Montana was conducted only until the end of June because of funding restrictions. Sulfation sites, however, were operated for the entire year.

The United States received a continuous flow in the East Poplar River throughout the year which exceeded the minimum flow requirements recommended to Governments by the International Joint Commission. On April 2, 1985, Montana requested delivery of the 617 cubic decametres of on-demand release it is entitled to. The requested amount was not delivered in the 37-day period requested but was delivered within 40 days. Runoff in the basin was again below normal during 1985.

Boron and total dissolved solids concentrations in the East Poplar River were below the long-term and short-term objectives recommended by the International Joint Commission to Governments. There were no exceedances of other water quality objectives recommended to Governments by the

International Joint Commission. Continued investigations of U.S. Geological Survey and Environment Canada quality assurance data have not resolved incompatibility for certain parameters. Additional quality assurance work has been recommended for 1986.

The outer limit of the cone of depression from coal seam dewatering remained about the same distance north of the International Boundary.

The total estimated seepage from the ash lagoons and polishing ponds was 0.750 litre per second, well below the seepage limits proposed by the International Poplar River Water Quality Board. The leachate front has been calculated to have advanced 4.23 metres towards Cookson Reservoir since the ponds were first filled.

Plant stack emissions did not cause or contribute to violation of Montana, United States, or Saskatchewan ambient air quality standards.

INTRODUCTION

The Poplar River Bilateral Monitoring Committee was authorized by the Governments of Canada and the United States under the Poplar River Cooperative Monitoring Arrangement dated September 23, 1980. A copy of the Arrangement is attached to this report as Annex 1. In 1985 the Arrangement was extended by mutual agreement for another year.

The Committee is composed of representatives of the Government of the United States of America, State of Montana, Government of Canada and Province of Saskatchewan. In addition to the representatives of Governments, two ex-officio members who are local representatives of the State of Montana and Province of Saskatchewan participate in the activities of the Committee. During 1985, the members and ex-officio members of the Committee were:

Mr. J. R. Knapton
U. S. Geological Survey
Chairman, U.S. Section

Mr. R. E. Driear
Governor's Office
Member, U.S. Section

Mr. C. W. Tande
Daniels County Commissioner
Ex-officio Member, Montana

Mr. G. W. Howard
Saskatchewan Environment
Acting Chairman, Canadian Section

W. D. Gummer
Environment Canada
Member, Canadian Section

Mr. J. R. Totton
Reeve, R.M. of Hart Butte
Ex-officio Member, Saskatchewan

The monitoring programs are in response to potential impacts of a transboundary nature resulting from Saskatchewan Power Corporation's coal-fired thermal generating station and ancillary operations near Coronach, Saskatchewan. Monitoring is conducted in Canada and the United States at or near the International Boundary for quantity and quality of both surface water and ground water and for air quality. Participants from both countries, including Federal, Provincial, and State agencies, are involved in monitoring.

A responsibility of the Committee includes an ongoing quarterly exchange of data acquired through the monitoring programs. The exchange of monitoring information was initiated with the first quarter of 1981, and is an expansion of the informal quarterly information exchange program initiated between Canada and the United States in 1976. Special reports dealing with aspects of monitoring and monitoring results requested by the Committee are sometimes published. Any such reports are reviewed annually by the Committee. No such reports were received by the Committee in 1985. Exchanged data and reports are available for public viewing at the agencies of the participating governments or from Committee members.

The Committee also is responsible for an annual report to Governments which summarizes the monitoring results, evaluates apparent trends, and compares the data to objectives or standards recommended by the International Joint Commission (IJC) to Governments, or relevant State, Provincial, or Federal standards. The Committee reports to Governments on a calendar year basis, with the report for 1985 being the fifth report in

the series. The Committee is also responsible for drawing to the attention of Governments definitive changes in monitored parameters which may require immediate attention.

Another responsibility of the Committee is to review the adequacy of the monitoring programs in both countries and make recommendations to Governments on the Technical Monitoring Schedules. The Schedules are updated annually for new and discontinued programs and for modifications in sampling frequencies, parameter lists, and analytical techniques of ongoing programs. The Technical Monitoring Schedules listed in the annual report (Annex 2) are given for the forthcoming year. The Committee will continue to review and propose changes to the Technical Monitoring Schedules as information requirements change.

POPLAR RIVER POWER STATION AND MINING

Operation

The two units operated for the full reporting period. The 1985 operating statistics for the two units are shown in Table 1:

Table 1

1985 Operating Statistics for Generating Units No. 1 and No. 2

	Unit 1	Unit 2
Hours of Operation	8 219	8 066
Gross MWhr Generated	2 312 700	2 248 000
Availability (hours) (percent)	93.8	92.1
Capacity Factor (percent)	88.6	87.3
Number of Start Ups	10	11
Coal Consumed (tonnes)	1 966 911	1 911 298
Oil Consumed (tonnes)	1 084	1 659
Hours in Period	8 760	8 760

The average sulphur content of the coal in 1985 was 0.5 percent. Analyses were conducted by an independent laboratory according to ASTM procedure D3176. The sulphur content of the No. 2 fuel oil consumed at the Poplar River Power Station was 0.07 percent.

Three spills occurred in 1985, all due to ash line ruptures. On August 12, 1985 a maximum of 800 m^3 of ash recirculation water containing some ash spilled immediately south of the Poplar River Power Station. The spill was contained upstream of the drainage ditch control structures. Cleanup procedures were implemented and no spill materials entered Cookson Reservoir.

On October 22, 1985 approximately 90 m^3 of ash recirculation water and some ash spilled adjacent to the ash recirculation pumphouse. The pumphouse is located at the northwest corner of the polishing pond. Most of the spilled water flowed into the pumphouse sumps which discharge to the ash lagoons. The remaining spill liquid was contained in the immediate vicinity. Cleanup procedures were implemented and no spill materials entered Cookson Reservoir.

On December 1, 1985 approximately 2 m^3 of ash and an unknown quantity of ash recirculation water spilled near the sewage holding pond. Reliable evaluation of the spill volume was not possible due to adverse weather conditions and snow cover. For the same reasons, effective clean-up was not practical. However, the spill materials are contained upstream of the drainage ditch main control structure. The ash will be removed once weather conditions permit. Ash recirculation water from the spill will be monitored prior to release to Cookson Reservoir.

Construction

A fourth ash recirculation water pump was installed in the ash recirculation pumphouse improving ash handling reliability. Supplemental quantities of reservoir water for ash sluicing, often necessary during recirculation pump failure, will be reduced. This will help maintain a controlled ash lagoon water balance.

A cross dyke to elevation 764.4 m was constructed in the fall of 1985 separating Ash Lagoon No. 3 into a north and south section. The north section dyking and liner is complete. Installation of a return structure to the polishing pond and ash piping to Ash Lagoon No. 3 north is planned for 1986 spring.

An interceptor trench was constructed along the outside of the cross dyke and the remaining exposed southern portion of Ash Lagoon No. 2 east dyke. The trench consists of pervious sand fill and perforated pipe drainage to manhole catchment basin system. The trench is designed to prevent groundwater mounding effects of Ash Lagoon No. 2 and Ash Lagoon No. 3 north from adversely effecting the future construction of Ash Lagoon No. 3 south.

An online ball type recirculation condenser cleaning system was installed on Unit No. 1 in 1985. The system is identical to that installed on Unit No. 2 in 1984. The system will continuously recirculate charges of sponge rubber and abrasive coated sponge rubber balls through the condenser tubes to reduce marine and scale deposits on the water side of the tubes. A reduction in scale inhibitor chemical dosing to the cooling water inlet and an increase in intervals between condenser acid cleans will result.

Mining

Coal mining continued to the west of Girard Creek and will continue in a north westerly direction until 1989 or later.

Prairie Coal Limited has been requested by Saskatchewan Environment to undertake an environmental assessment of two new mining areas to the east and north of Cookson Reservoir (Figure 1). Guidelines for preparation of the impact statement asked the company to address such things as ground water, surface water and reclamation.

The impact statement should be completed in early 1987 and will subsequently be available for public review and comment.

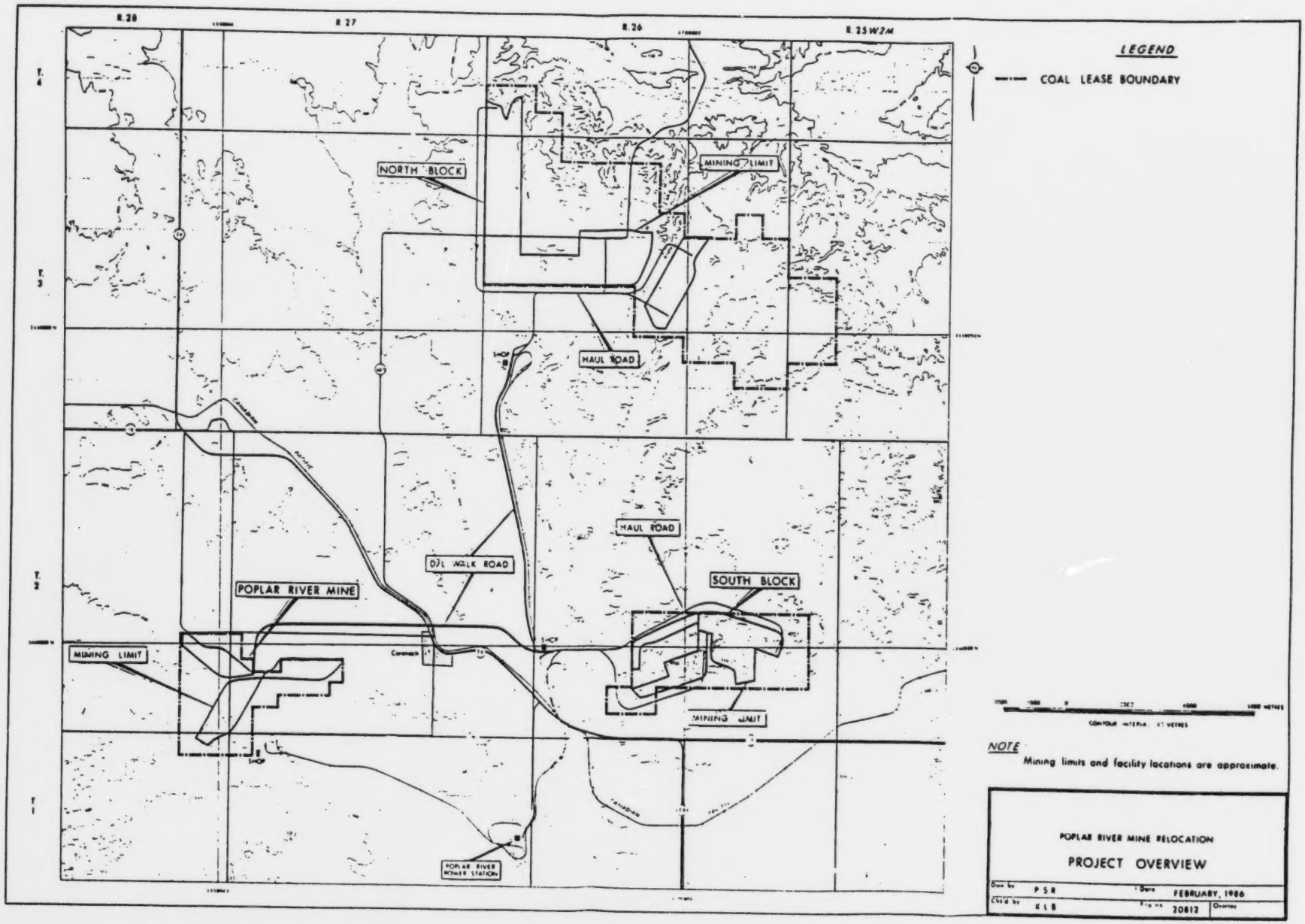

Figure 1 - Poplar River Mine Expansion

SURFACE WATER QUANTITY

Streamflow

Streamflow in the Poplar River basin was below normal during 1985, assuming the recorded flow of the Poplar River at the International Boundary is a good indicator of basin runoff conditions. The March to October recorded flow volume at that gauge was 7 710 cubic decametres (dam^3), or 47 percent of the long-term average. A comparison of the flows of 1985 with those of the 1951-80 median flow is shown in Figure 2.

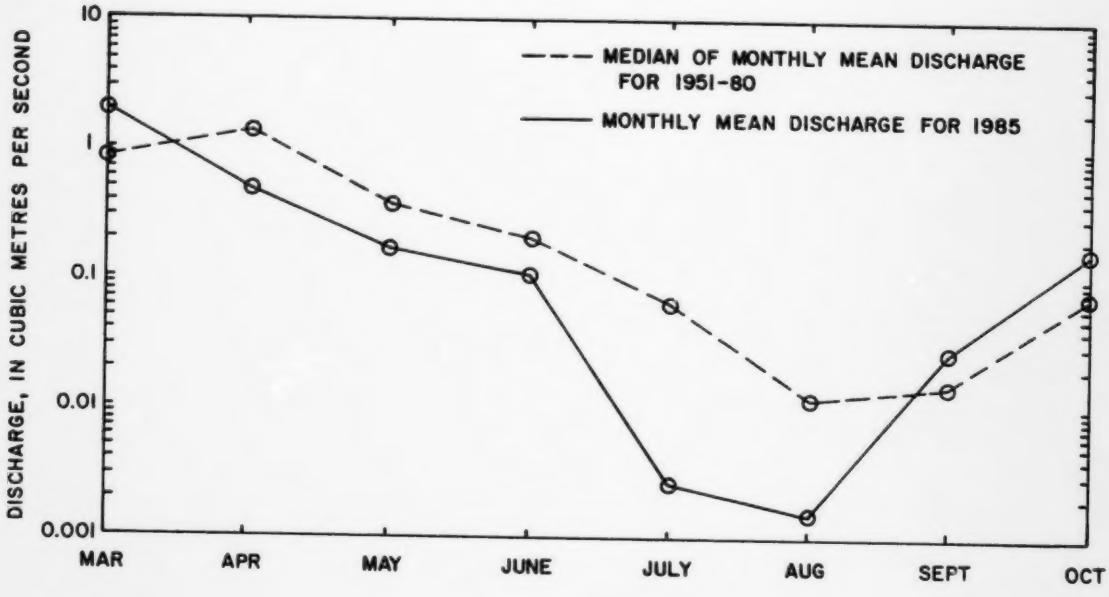

Figure 2 - Discharge during 1985 compared with median discharge for 1951-80 for the Poplar River at International Boundary.

The recorded flow volume of the East Poplar River at the International Boundary for 1985 was 2 980 dam^3, or 21 percent of the mean annual flow since the completion of Morrison Dam in 1975.

Minimum Flows

The recorded runoff volume of the Poplar River at the International Boundary from March 1 to May 31, 1985 was 6 890 dam^3. For the purposes of interpreting the apportionment recommendations of the IJC, the recorded flow is assumed to be the natural flow. Based on these recommendations, this volume entitled the United States to a minimum discharge of 0.057 cubic metre per second (m^3/s) from June 1 to August 31, 1985 and 0.028 m^3/s from September 1, 1985 to May 31, 1986 on the East Poplar River at the International Boundary. The minimum flow of 0.028 m^3/s for the first 5 months of 1985 had previously been determined on the basis of the March 1 to May 31, 1984 Poplar River volume.

The recorded flow of the East Poplar River at the International Boundary exceeded the recommended minimum throughout the year. A minimum daily discharge of 0.051 m^3/s occurred on February 12. A hydrograph of flow in the East Poplar River at the International Boundary and the minimum flow as recommended by the IJC is shown in Figure 3.

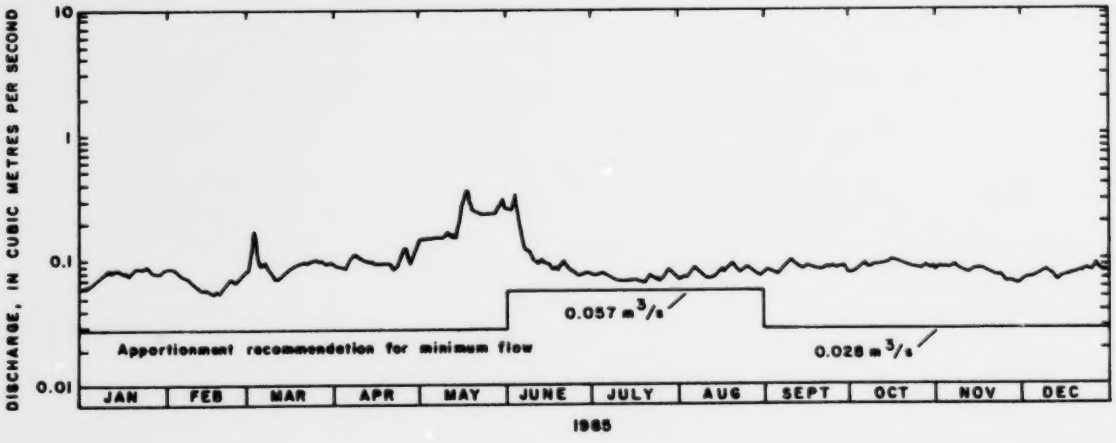

Figure 3 - Hydrograph of Water Discharge of the East Poplar River at the International Boundary and Recommended Minimum Flow.

Reservoir Storage

Cookson Reservoir was near the full-supply level all year, with contents increasing from 34 800 dam^3 on January 1 to a maximum of 39 500 dam^3 on April 19. Elevations and contents for selected dates are given in Table 2.

Table 2

Cookson Reservoir Storage Statistics for 1985

Date (1985)	Elevation (metres)	Contents (cubic decametres)
January 1	752.149	34 800
April 19	752.805	39 500
December 31	752.222	35 400
Full-Supply Level	753.000	40 900

Storage increased during the year by 600 dam^3 due to above normal precipitation in the fall and base flows in Girard Creek which are maintained by dewatering operations at the Poplar River Mine. These flows assisted in offsetting the evaporative losses and releases from the reservoir.

On-Demand Release

Based on the apportionment recommendations of the IJC, the United States is entitled to an on-demand volume of 617 dam^3 at any time from June 1, 1985 to May 31, 1986. As of December 31, 1985 Montana had not requested this release. The on-demand volume entitlement for 1984 of 617 dam^3 was requested on March 26, 1985, and corrected on April 2, 1985, to be delivered April 25 to May 31. This volume was delivered April 25 to June 3.

SURFACE WATER QUALITY

East Poplar River at the International Boundary

The 1981 report by the IJC to Governments recommended:

> For the March to October period, a maximum flow-weighted concentration should not exceed 3.5 mg/L boron and 1500 mg/L for total dissolved solids for any three consecutive months in the East Poplar River at the International Boundary.
>
> For the March to October period, a long-term average of flow-weighted concentrations should be 2.5 mg/L or less for boron, and 1000 mg/L or less for total dissolved solids in the East Poplar River at the International Boundary.

Compliance of the East Poplar River water quality with the proposed short-term objectives for boron and total dissolved solids (TDS) is tested by calculating the 3-month (90-day) moving flow-weighted concentration for each, advancing 1 month at a time while dropping the first month of the three-month period. Prior to 1982, determination of compliance was based strictly on instantaneous samples. Since the beginning of 1982, daily TDS and boron concentrations have been computed from a regression relationship with specific conductance. However, the data from both instantaneous samples and from calculation of TDS and boron are presented.

The Bilateral Monitoring Committee has adopted the approach that for the purpose of determining compliance with the proposed IJC long-term objectives, the boron and TDS data are best graphically plotted as a 5-year flow-weighted moving average which is advanced one month at a time. Each point represents the flow weighted concentration for a 5-year period, with two and one-half years on either side of the plotted point. It must be emphasized that the data base is comprised of all data collected over the twelve months of all years.

Total Dissolved Solids

The proposed short-term objective for TDS is 1,500 mg/L. A plot of the 3-month moving flow-weighted concentration is shown in Figure 4a. No exceedences have been observed in either the grab sample-generated data or in the regression-calculated data over the period of record.

The observed relationship between TDS and specific conductance for the entire period of record is:

TDS = (0.642 X specific conductance + 9.32) (R-squared = 0.87)

The long-term, 5-year moving flow-weighted concentrations for TDS is shown in Figure 4b. The long-term flow-weighted values remained well below the proposed objective of 1,000 mg/L. Because flow weighting is calculated across five years, a radical change in flow or the instantaneous concentrations can significantly alter the plot of the moving 5-year concentrations (see Figure 4b). The decrease depicted in the graph,

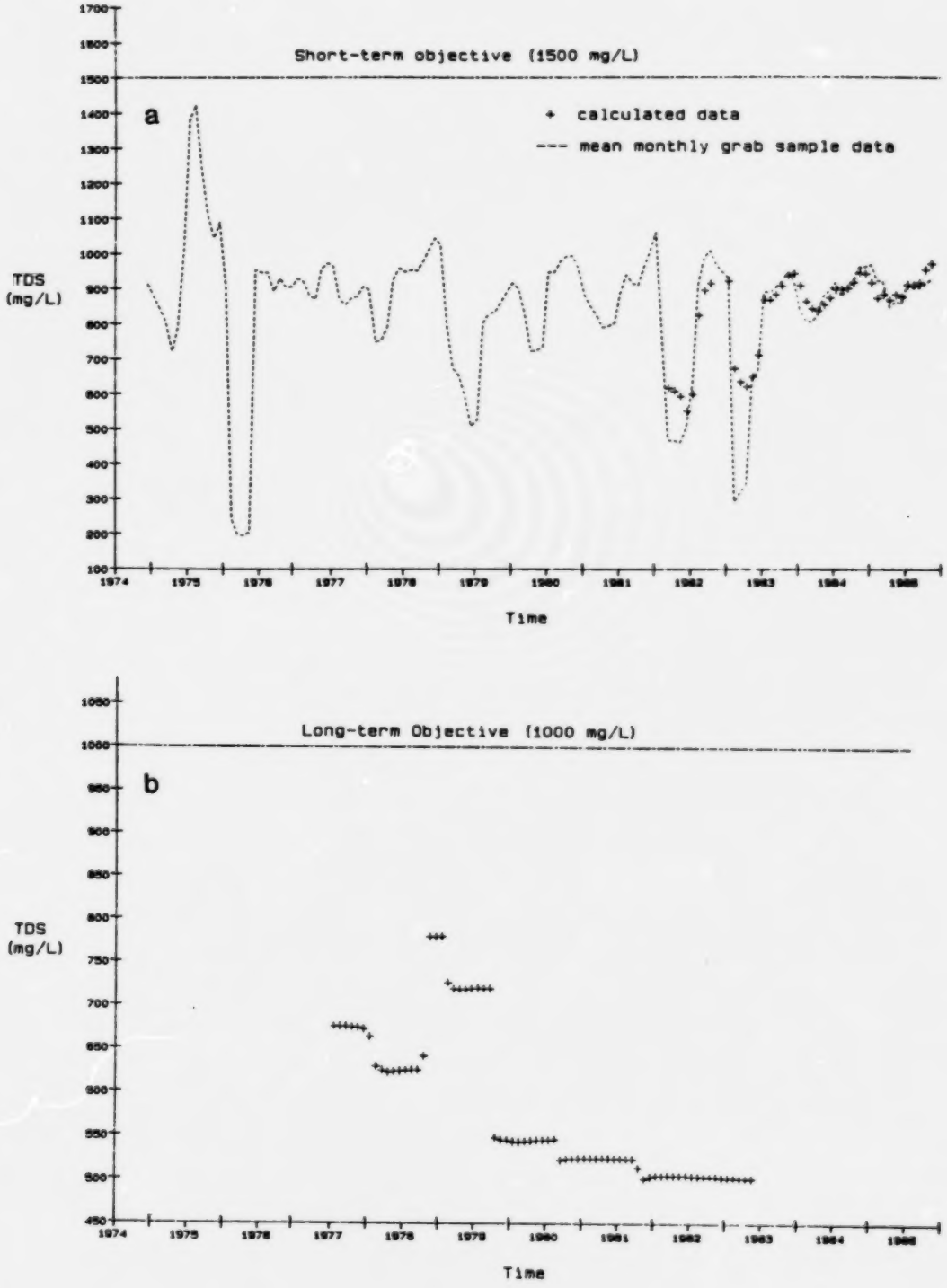

Figure 4 (a) Three-month Short-term Flow-weighted Concentration for TDS, East Poplar River at the International Boundary; (b) Five-year Long-term Flow-weighted Concentration for TDS, East Poplar River at the International Boundary

from 721 to 548 mg/L, is attributed to the very high flows of March and April 1982. The flow was approximately 30 m^3/s in April, almost two orders of magnitude higher than the flows recorded at time of water sample collection during the period July 1979 to February 1982.

The instantaneous concentrations for TDS ranged from 780 mg/L in May 1985 to 1000 mg/L recorded in November 1985 with an annual mean of 911 mg/L.

Boron

The proposed short-term objective for boron is 3.5 mg/L. Figure 5a shows the 3-month moving flow-weighted concentration. There were no excursions over the period of record (1975 to 1985). The maximum flow-weighted concentration during 1985, calculated from the regression equation, was 1.85 mg/L. Whereas the maximum calculated from the grab-sample data was 1.75 mg/L. The maximum instantaneous boron concentration observed was 2.0 mg/L.

The relationship between boron and specific conductance over the entire period of record is described by the equation:

B = (0.00146 X specific conductance) - 0.26 (R-squared = 0.75)

The trend in each annual curve is similar. As autumn approaches, the 3-month flow-weighted concentrations rise gradually as the ground water contribution accounts for a greater percentage of the streamflow. In 1984 and 1985 the amplitude of the annual fluctuation is considerably less than in some previous years. This is probably due to the paucity of runoff from snowmelt during the spring of those two years.

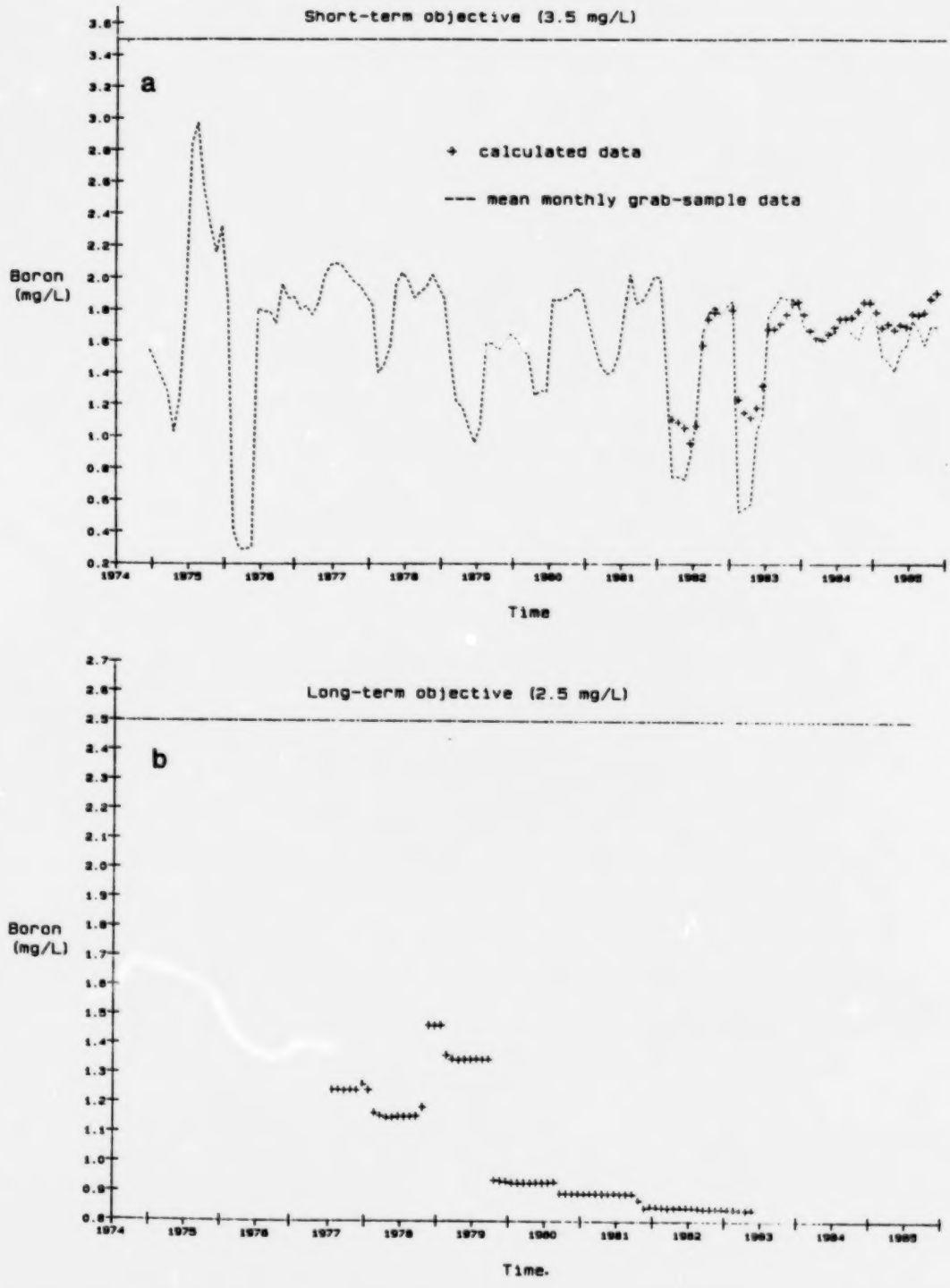

Figure 5 (a) Three-month Short-term Flow-weighted Concentration for Boron, East Poplar River at the International Boundary; (b) Five-year Long-term Flow-weighted Concentration for Boron, East Poplar River at the International Boundary

The long-term 5-year moving flow-weighted mean concentration is presented in Figure 5b. Although only the irrigation season (March to October) was of concern to the IJC, all yearly values are included in Figures 6 & 7, in order to better present long term trends in the data.

The 5-year moving average boron concentration does not at any time during the period of record, exceed the 2.5 mg/L recommended long-term objective. The maximum value for observed is 1.47, recorded for the 5-year period July 1976 to June 1981 (plotted at the January, 1979 location in Figure 5b). The large change in the plot, from 1.35 to 0.94 mg/L is attributed to the very high flows of April 1982 (see discussion for TDS) coupled with a low boron concentration.

Other Water Quality Characteristics

Table 3 shows the multi-purpose water quality objectives recommended by the International Poplar River Water Quality Board to the IJC. The number of samples collected for each parameter is also shown. No exceedences of the recommended multi-purpose objectives occurred in 1985.

Environment Canada data indicate that the dissolved mercury content of the East Poplar River was at or below the analytical detection limit of 0.02 ug/L.

Cookson Reservoir

There are no trends yet evident in the water quality of Cookson Reservoir. Boron and TDS concentrations remained below 2.0 and 1000 ug/L, respectively. Dissolved oxygen levels remained high. The data provided by Saskatchewan Environment do not exceed the objectives for the East Poplar River at the International Boundary (Table 3).

Table 3

Recommended Water Quality Objectives, Excursions and the 1985 Sampling Program, East Poplar River at the International Boundary (units in mg/L, except as otherwise noted)

Parameter	Objective	No. of samples USA	Canada	Excursions
Objectives recommended by IJC to Governments				
Boron-total	Note (1)	14	15	nil
TDS	Note (1)	14	14	nil
Objectives recommended by Board to IJC				
Aluminum-dissolved	0.1	3	13	nil
Ammonia un-ionized (N)	0.2	14	15	nil
Cadmium-total	0.0012	2	14	nil
Chromium-total	0.05	3	14	nil
Copper-dissolved	0.005	2	nil	nil
Copper-total	1.0	3	14	nil
Fluoride-dissolved	1.5	14	13	nil
Lead-total recoverable	0.03	3	14	nil
Mercury-dissolved	0.0002	nil	14	nil
Mercury-whole fish (mg/kg)	0.5	nil	nil	-
Nitrate (N)	10	14	15	nil
Dissolved Oxygen	Note (2)	12	13	nil
S.A.R.	10	14	14	nil
Sulphate	800	14	14	nil
Zinc-total	0.03	3	14	nil
Temperature (deg. C)	Note (3)	12	10	nil
pH (pH units)	Note (4)	12	13	nil
Coliform				
- fecal (no./100 ml)	2,000	nil	13	nil
- total (no./100 ml)	20,000	nil	13	nil

Note:

(1) March to October, long-term average of flow-weighted concentrations should be $\leq$2.5 mg/L for boron, and $\leq$1,000 mg/L for TDS with a maximum flow-weighted concentration not to exceed 3.5 mg/L for boron and 1,500 mg/L for TDS for any 3-month period during this time.

(2) 5.0 (minimum April 10 to May 15), 4.0 (minimum rest of year).

(3) Natural (April 10 to May 15), less than 30 deg. C (rest of year).

(4) 6.5 (minimum) and less than 0.5 above natural.

Data Comparison

Quality control sampling was carried out on June 11, 1985, during which triplicate samples were collected by Environment Canada and the United States Geological Survey (Table 4).

Table 4

Data Comparison, June 11, 1985 Sampling Trip
(units are mg/L)

Parameter	Environment Canada No.	Range	Mean	U.S. Geological Survey No.	Range	Mean	Difference Net	% of USGS
T.D.S.	3	24	839	3	20	940	101	10.7
Specific Cond. (us/cm)	3	10	1384	3	0	1450	66	4.6
Alkalinity (Tot)	2	1	396	3	14	468	72	15.4
Ca-dissolved	3	1.9	44.9	3	3	55	10	18.2
Cl-dissolved	3	0.1	5.1	3	0.2	5.9	0.8	13.6
F-dissolved	3	0.10	0.46	3	0	0.3	0.2	67.
SO_4-dissolved	2	4.3	288	3	0	310	22	7.1
SiO_2-dissolved	2	0.5	10.0	3	0	11	1	9.1
B-dissolved	3	0.05	1.4	3	0	1.9	0.5	26.3
Fe-dissolved	3	0.03	0.14	3	0.003	0.010	0.13	1300.
Ni-dissolved	3	0	0.002	3	0.002	0.006	0.004	67.
Hardness	3	9	321	3	10	353	32	9.1

Significantly differing TDS and Boron results for the June samples gave rise to a second quality control sampling, which was carried out on December 17, 1985.

Samples from the December exercise were split and sent to different labs. Canadian samples were sent to the Saskatchewan Research Council (SRC), and to the Environment Canada Regional (EC-REG) and National laboratories (EC-NAT).

In the United States, samples were sent to the U.S. Geological Survey laboratory (USGS), the Montana Department of Health and Environmental Sciences (MDHES), and to the Montana Bureau of Mines and Geology (MBMG). The data for TDS, laboratory specific conductance and boron are shown in Table 5.

Table 5

Data Comparability, December 17, 1985 Sampling Trip
(units are mg/L)

	Environment Canada			U.S. Geological Survey		
					M-HEALTH	
Parameter	SRC	EC-NAT	EC-REG	MBMG	MDHES	USGS
Total Diss. Solids	1124	908	-	979	987	950
Spec Cond (us/cm)	1450	1450	1470	1496	1497	1550
Boron-dissolved	1.7	-	1.5	1.7	1.8	1.8

A comparison of June quality control data indicates significant differences in the calcium and alkalinity results which are used in the calculation of total dissolved solids. The December results showed some improvement in the comparability of boron results. It does appear, however, that the Water Quality Branch regional laboratory reports consistently lower boron concentrations than the USGS laboratory. Additional inter-agency quality control work will have to be undertaken in 1986, with the inclusion of some spiked samples and blanks.

GROUND WATER QUANTITY

Coal Mine Dewatering in Saskatchewan

Discharges

Due to coal mine dewatering activities, a total of 7,083 dam^3 (5,742 acre-feet) of ground water was discharged during 1985. This amounts to 9.6 percent less pumpage than in the previous year. A summary of the monthly pumpages from all the coal dewatering wells is shown in Table 6.

Table 6

1985 Monthly Pumpages from Mine Dewatering Activities

Month	Pumpages	
	Total (dam^3)	Rate (L/s)
January	626	234
February	603	249
March	668	249
April	629	243
May	576	215
June	594	229
July	573	214
August	547	204
September	531	205
October	616	230
November	536	207
December	584	218
TOTAL	7,083 dam^3 (5,742 acre-feet)	

The ground water was discharged at 14 locations during 1985. Twelve discharges were to Girard Creek, one was directly into Cookson Reservoir and one was into a tributary of Goose Creek. From the discharge to the Cookson Reservoir, 68.1 dam^3 were diverted directly into the Town of Coronach water supply. No water from this Goose Creek discharge reached the main stem of Goose Creek.

Water Levels

Two piezometric pressure maps, dated June and December, 1985, were prepared by Prairie Coal Ltd.[1] Figure 6 was compiled from the December map and shows the cone of depression formed by the pressure contours in the Hart coal seam. The southern extent of the cone of depression at the end of 1985 is unchanged from its position in the previous year. The position of the one metre contour therefore remains at 1.8 kilometres north of the International Boundary.

Montana

Quarterly water levels were read in 21 wells in 1985. Wells 5, 10, 14, and 15 were equipped with continuous recorders.

Additional development (flushing, surging, pumping) was done on wells 13 through 19, 21 and 22 in May of 1985. This resulted in a readjustment of static water levels in wells 16, 17, 18 and 21.

Water levels in the 10 original wells continue to fluctuate within one foot from their average values. There appears to be no noticeable impact caused by mine dewatering activity in Saskatchewan.

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1 Effective December 1, 1984, ownership and operation of the Poplar River Mine were transferred from the Saskatchewan Power Corporation to Prairie Coal Ltd.

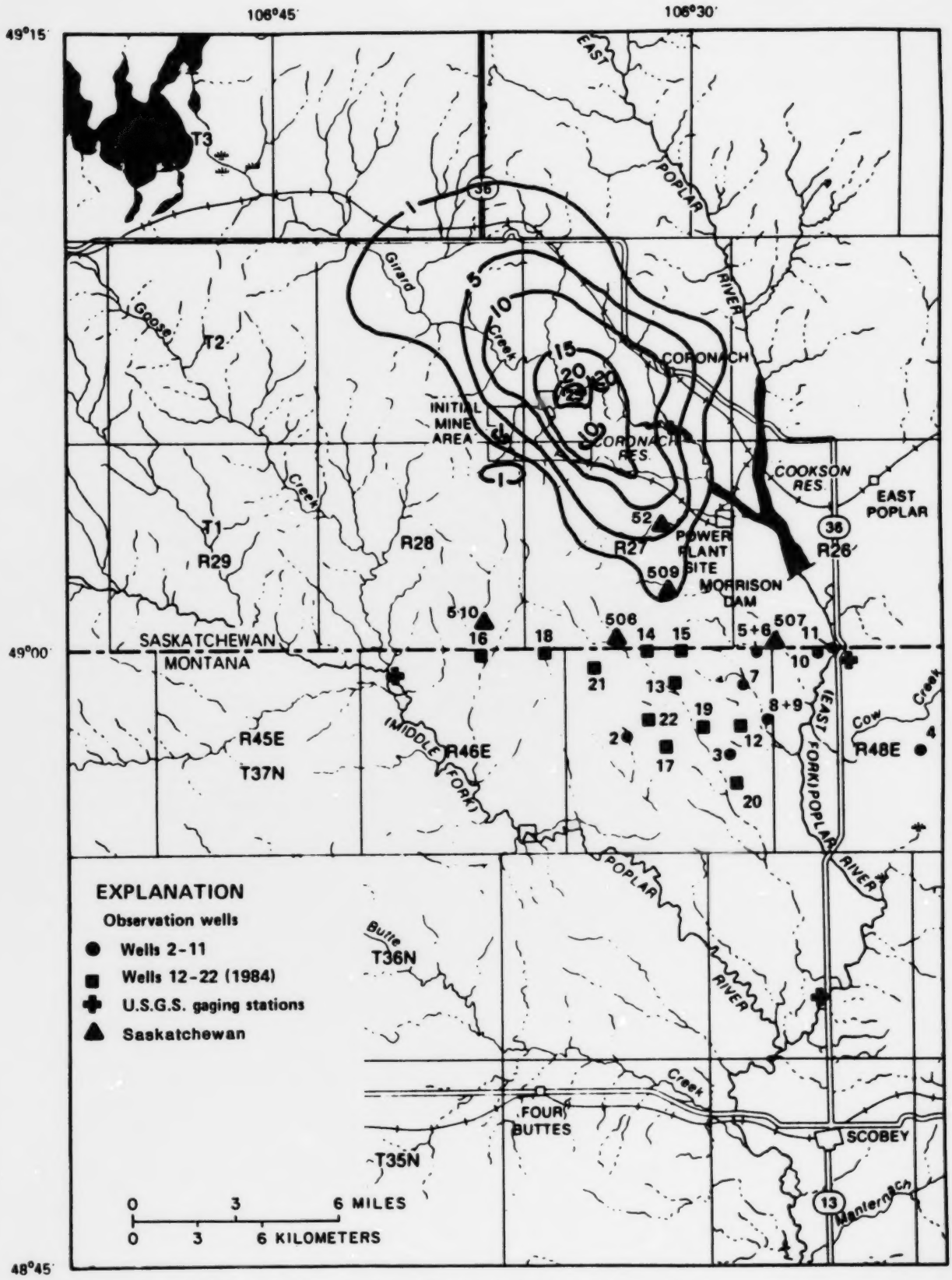


Figure 5 Cone of Depression in the Hart Coal Seam from Dewatering Activities as of December, 1985

GROUND WATER QUALITY

Saskatchewan

Ground water sampling continued in 1985 at the locations specified in the Technical Monitoring Schedules.

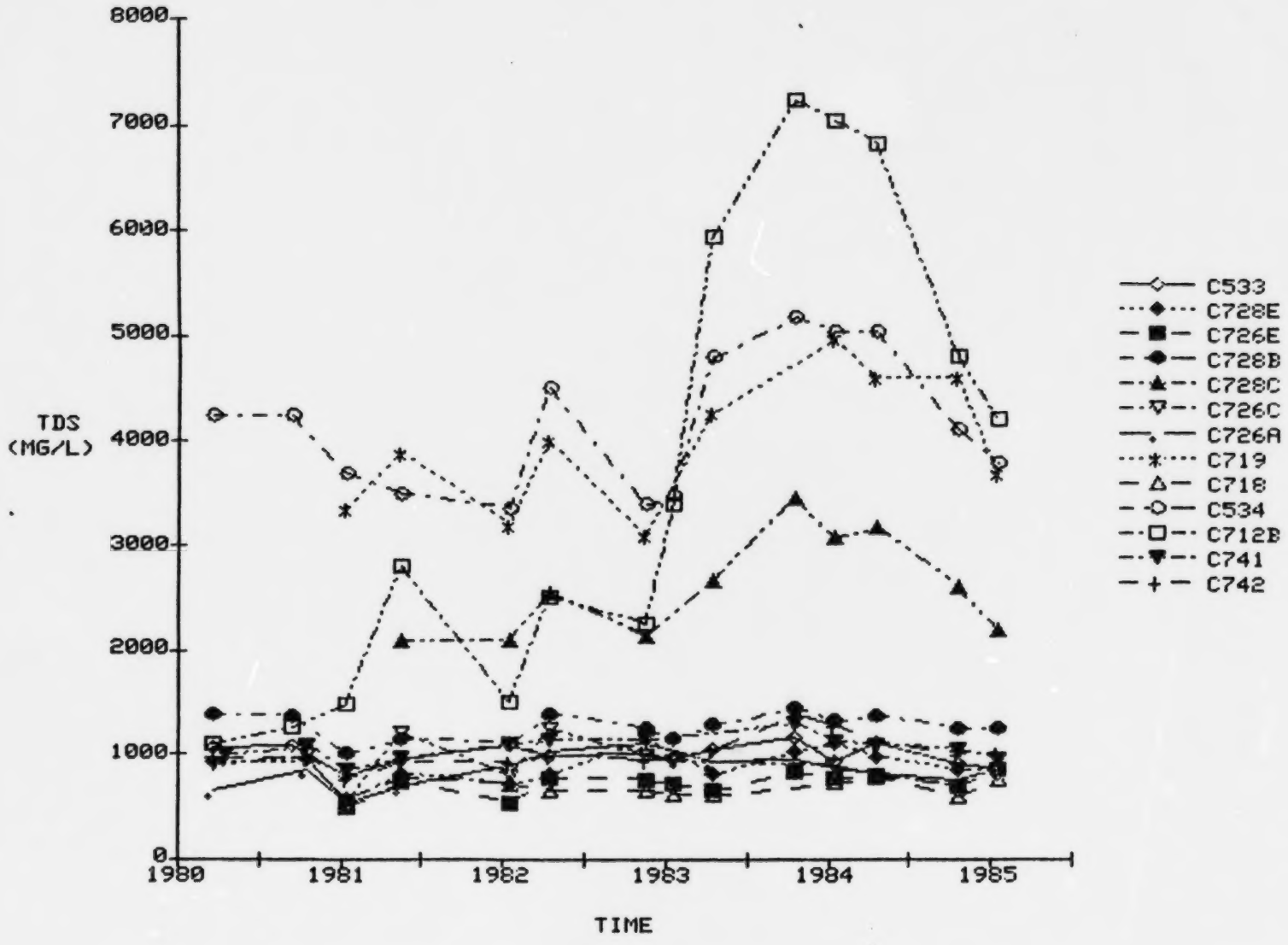
Water Quality in the Tills

Waters from the tills are of generally poorer quality than those from the Empress Gravels. This is illustrated in Figure 7, where TDS has been plotted for each piezometer. The higher, and more variable concentrations are associated with piezometers completed in till, whereas TDS levels in Empress-completed piezometers rarely exceed 1,200 mg/L.

Piezometer C712B at location 2a, just to the north of the polishing lagoon displayed an increase in uranium concentration over 1984 to mid-1985. The extremely high uranium values reported in 1985 are possibly questionable, being about ten times the expected level. The first-quarter of 1986 results for C712B should be scrutinized to determine whether a real trend is developing, or whether the high uranium concentrations noted in April and July 1985 were in error. No other parameter trends are in evidence at this location.

Locations 2b (C718) and 2c (C719), near the north edge of the polishing lagoon similarly displayed no consistent water quality trends over the period October 1983 to the end of 1985, although the uranium concentration at C719 fluctuates widely during the period October 1984 to October 1985.

FIGURE 7: TOTAL DISSOLVED SOLIDS CONCENTRATIONS; EAST POPLAR RIVER MONITORING PIEZOMETERS



At location 9a, at the west end of the polishing lagoon, piezometers 728B and 728C show a general increase in uranium level over the period 1983 to July 1985, but the concentrations drop off again slightly in October 1985.

The variability in the concentration for most chemical species observed both spatially and temporally in the tills can probably be attributed to localized geochemical conditions adjacent to piezometer intakes and to variability in recharge rates through the tills. In the case of sulphate, this is supported by the observation of gypsum lenses in the tills in drill cuttings recovered at the time of piezometer installation. The ground water chemistry in the tills is therefore influenced by the amount of net ground water recharge over the area, as well as the mineralogic content of the tills at the sampling point and along the flow path of the infiltrating water.

Water Quality in the Empress Gravels

No significant water quality trends are evident in the Empress Gravels. Figure 7 shows that TDS levels remain generally unchanged over the period of record (1980 to 1985).

Piezometer C533 appears to have undergone a very slight increase in chloride concentration over the period of record, but no other chemical species have increased consistently. For instance, uranium has remained at a relatively stable concentration since early 1981 in all Empress-completed piezometers (C533, C534, C726E, and C728E). Boron levels decreased in C533 since 1980, and showed no significant trends in C534, C726E, and C728E.

The average hydraulic conductivity of the Empress Gravels is some five orders of magnitude higher than that of the tills. The volume of water flowing through the Empress Gravels would therefore, under similar head conditions be correspondingly much higher than the volume of leakage from the overlying tills into the gravels. Because of this, the dilution effect would be large enough so as to mask or otherwise render indeterminable the effects of increased leakage, on the water quality of the gravels.

Montana

Water quality samples for wells 2 through 11 were collected in August, 1985. No significant changes in water chemistry have been observed. After additional development on wells 13 through 19, 21 and 22 (by bailings), samples were collected from wells 13, 14, 15, 17, 18, 19, 21 and 22.

ASH LAGOON QUALITY AND QUANTITY

The ash lagoon system at the Poplar River Power Station continues to be operated on a closed system basis with no discharges to surface waters. During 1985, most of the sluiced ash was directed into Ash Lagoon No. 2. The normal operation has been using Ash Lagoon No. 2 and the polishing pond in series. Water from the polishing pond is returned to the plant for ash sluicing. End of quarter water depths in Ash Lagoons No. 1 and 2 were in the 3.2 - 6.1 m and 3.2 - 4.2 m ranges respectively. A small amount of ash and water were slurried to Ash Lagoon No. 3 to increase water levels and, to protect its lining while this lagoon was not in use.

Seepage calculations were carried out in 1985 using the methods developed by T.E.A. Prickett, P.E., of Urbana, Illinois. Results of the calculations for Ash Lagoons No. 1 and 2 and the polishing pond are as follows:

Table 7

Calculated Seepage Rates

Source	Rate (L/s)
Polishing Pond	0.239
Ash Lagoon No. 1	0.172
Ash Lagoon No. 2	0.339
Total Seepage	0.750

The 1985 calculated seepage was greater than that calculated for the year 1984. This has been attributed largely to the loading effects on Ash Lagoon No. 2. The calculated total seepage is well below the seepage limits (5.0 L/s to Cookson Reservoir and 2.0 L/s to the East Poplar River) proposed in 1979 by the International Poplar River Water Quality Board of the International Joint Commission. The permeability of the Ash Lagoons Nos. 1 and 2 and polishing pond liners were calculated and found to be the same order of magnitude (10^{-9} cm/s) as originally calculated by T.E.A. Prickett.

The advancement of the seepage front towards the reservoir in the oxidized till was calculated at 4.23 m since the ponds were initially filled, which is an increase of 1.75 m since 1984. Whereas the seepage front in the Empress formation was calculated to have advanced 628 m southeast of the lagoons, an increase of 144 m since 1984. However, examination of Empress formation and till water chemistry have not shown significant changes attributable to lagoon seepage. Thus leachate flow into Cookson Reservoir and into the East Poplar River was zero to date.

Saskatchewan Environment requires that the Saskatchewan Power Corporation maintain the stability of the ash lagoon system dykes. In addition to the regular visual inspections, an annual investigation by a geotechnical engineer was conducted in May, 1985. The freeboard requirements were exceeded during a short time in the late spring of 1985 in order to minimize any ash blowing problems from Ash Lagoon No. 1. This matter has been remedied and satisfactory freeboard maintenance has been subsequently

practised. Additional piezometers were installed in July, 1985 by SPC to provide information on the ground water regime adjacent to Ash Lagoon No. 3

SPC has, since May, 1983, undertaken analyses of filtered ash lagoon water samples to obtain appropriate information on potential leachate quality. Generally the water quality data show increases in the ash lagoons and the polishing ponds for sodium, potassium, sulphate, silica, total dissolved solids, fluoride, boron, molybdenum, and strontium; and notable variability in the levels for uranium, and vanadium. In addition, there were some decreases noted for other measured variables such as lead, mercury and recently zinc. The changes are to be expected in a closed system of this type.

AIR QUALITY

Saskatchewan

Ambient sulphur dioxide monitoring began at Coronach in July 1979. To date, a few detectable concentrations have been recorded at this site. There were no recorded violations of Saskatchewan Environment's hourly or 24 hour standards of 17.0 pphm and 6.0 pphm respectively (Figures 8 and 9). The highest value of 7.5 pphm occurred on November 12 at 1200 hours. Weather information for this day indicates winds blowing from the southwest quadrant, which would indicate the power plant as the probable source. The highest 24 hour value of 0.4 pphm occurred on May 24 and November 12. Weather data indicates winds blowing from the southern quadrants 46 and 42% of the time respectively.

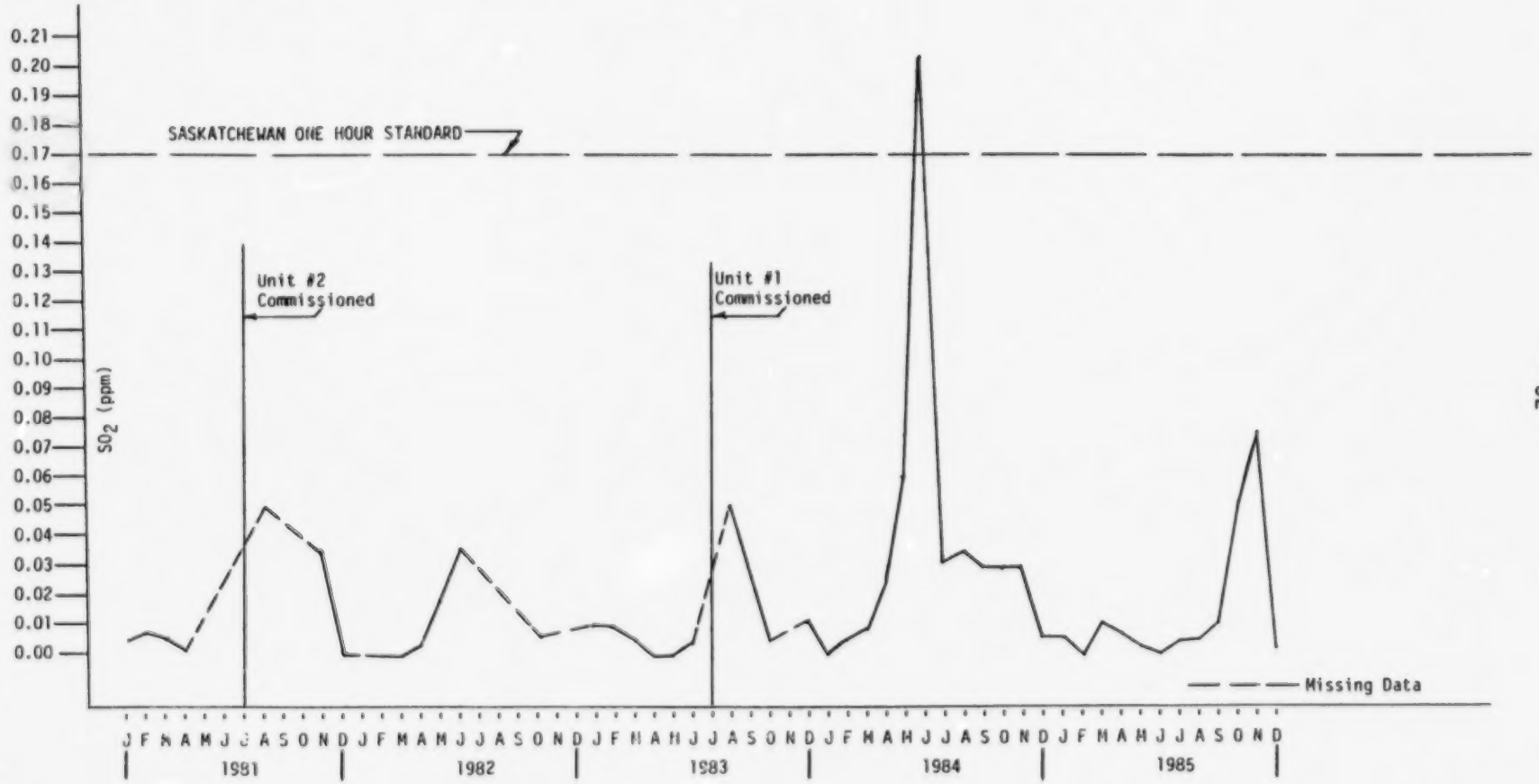
Suspended particulate concentrations at Coronach did not exceed Saskatchewan Environment's 24 hour average standard of 120 micrograms per cubic metre (ug/m^3/24 hours), as compared to 6 exceedances in 1984. The annual geometric mean fell from 39.8 ug/m^3 in 1984 to 24.8 ug/m^3 in 1985 and continues to be well below the Saskatchewan standard of 70.0 ug/m^3.

In-stack monitoring results showed a similar variance in 1985 to that of 1984. Daily nitrogen oxide concentrations ranged from 400 to 1216 milligrams per cubic metre (mg/m^3) with an average yearly concentration of 757 mg/m^3 as compared to 800 mg/m^3 in 1984. However, operating problems continued to plague the nitrogen oxides monitor; the monitor was not available 62% of the time. Daily sulphur dioxide concentrations ranged from 1554 to 4710 mg/m^3 with an average yearly concentration of 2660 mg/m^3 as compared to 2600 mg/m3 in 1984.

SASKATCHEWAN MAXIMUM HOURLY SO_2 AIR QUALITY DATA

CORONACH WATER TREATMENT PLANT

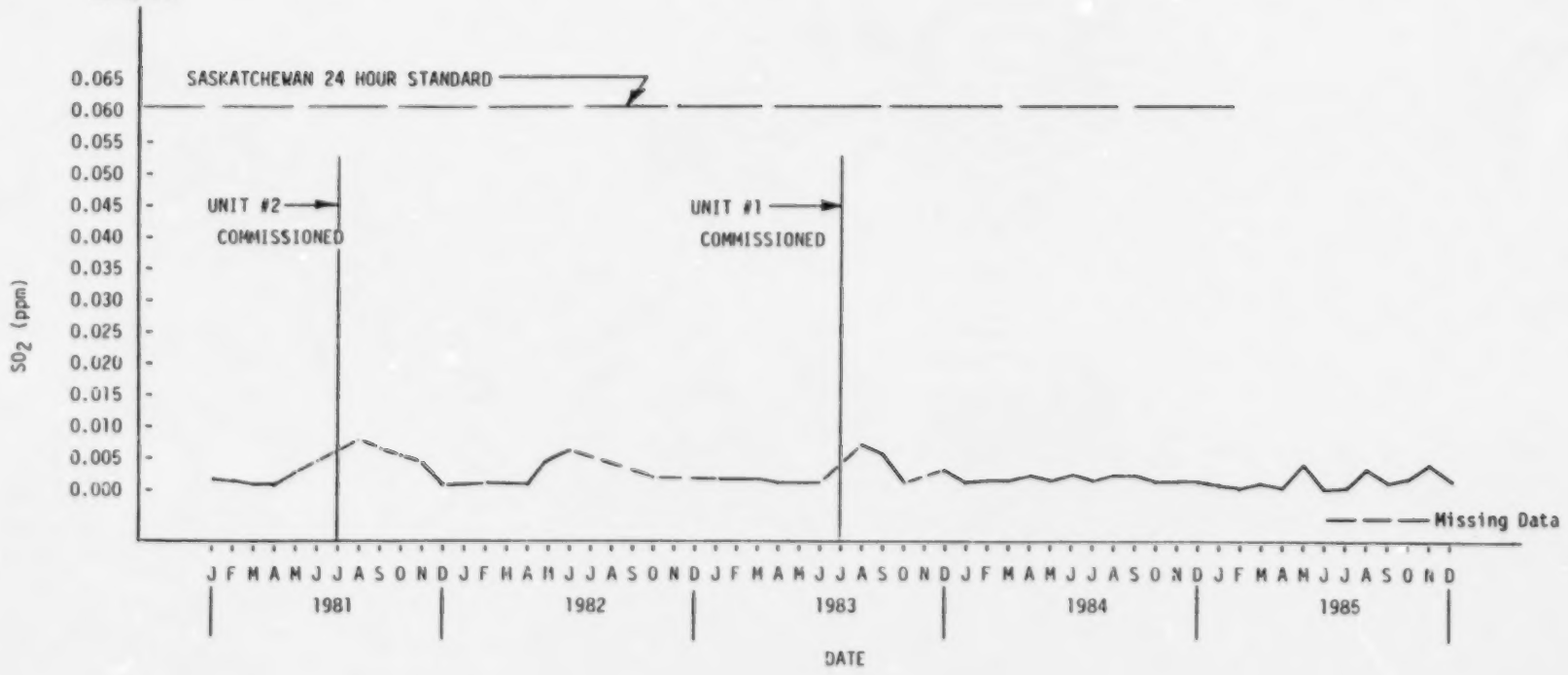
FIGURE 8



SASKATCHEWAN MAXIMUM DAILY SO_2 AIR QUALITY DATA

CORONACH WATER TREATMENT PLANT

FIGURE 9



Sulphur dioxide emissions consisted of 8.5×10^{-3} tonnes per megawatt hour due to firing on coal and 8.0×10^{-5} tonnes per megawatt hour due to firing on oil. Total coal consumption for 1985 was 3,878,000 tonnes and oil consumption was 2,743 tonnes (3,044 cubic metres).

Average daily opacity readings ranged from 1 to 100%, with a yearly average of 19% as compared to 22% in 1984. Saskatchewan's opacity standard is 40%. In most instances, opacity violations generally occur during process start-up, shut down or when one of the precipitators experiences a power trip.

Montana

The State of Montana operated three primary air monitoring sites and five additional sulfation rate sites in the Poplar River area of Montana during 1985. The parameters monitored included: sulphur dioxide, total suspended particulate, fine particulates, sulfation rate, wind speed, wind direction, and temperature. The primary air monitoring sites were operated from July 1984 through June 1985 because the 1983 Montana Legislature provided funding for only one additional year of monitoring which commenced after both Coronach units sustained near-capacity operation. The sulfation rate sites were operated for the entire year by utilizing funding from Montana's general air quality budget. The monitoring results are summarized in Table 8.

Table 8

Summary of Air Quality Monitoring Results During 1985 in Montana

Sulphur Dioxide (pphm)

Site	Highest 1-hr	Highest 3-hr	Highest 24-hr	Annual Avg.
Border (6)[1]	12.7	6.4	0.9	0.1
Hanrahan (6)[1]	3.1	2.4	0.7	0.1

Sulfation Rate (mg/100 cm^2/day)

Site	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Richardson	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.05	.05
Microwave Tower	.10	.00	.00	.00	.00	.00	.00	.01	.00	.00	.05	
Flaxville	.06	.00	.00	.01	.00	.00	.00	.00	.00	.00	.04	.10
TV Tower Hill	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00	.04	.04
Scobey Downtown	.07	.01	.00	.00	.00			.00	.00	.00	.05	.06
Four Buttes	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00
International Boundary	.06	.00	.00	.00	.00	.00	.00	.04	.00	.00	.00	.10
International Boundary (SO_2)[2](6)[1]	.10	.04	.06	.03	.07	.20						
Hanrahan	.00	.00	.00	.00	.00	.00	.00	.01	.00	.00	.04	.07
Hanrahan (SO_2)[2](6)[1]	.06	.11	.15	.02	.07	.20						

Total Suspended Particulate (ug/m^3)

Site	Highest 24-hr	2nd Highest 24-hr	Geometric Mean	Arithmetic Mean
Border (6)[1]	82	62	26.5	29.6
Hanrahan (6)[1]	73	68	18.6	22.9
Richardson (6)[1]	110	69	19.3	27.8

Fine Particulates (ug/m^3)

		Highest 24-hr	2nd Highest 24-hr	Arithmetic Mean
International Boundary (6)[1]	<2.5 micron	16.2	10.8	6.0
	2.5-15 micron	54.3	33.7	9.3
	<15 micron	59.0	49.9	15.3
Hanrahan (6)[1]	<2.5 micron	4.0	3.9	2.4
	2.5-15 micron	45.1	38.1	10.9
	<15 micron	49.1	41.8	13.3

NOTES:

1 Parentheses denote the number of sample months.

2 The monthly sulphur dioxide averages (pphm) measured by the continuous sulphur dioxide analyzers are presented below the corresponding sulfation rate data for comparison purposes.

During the first half of 1985, sulphur dioxide concentrations remained less than both Montana and United States ambient air quality standards. The maximum 1-hour concentration of 12.7 pphm was recorded at the International Boundary site during January. This concentration is approximately one-fourth of the Montana standard. The highest 24-hour concentration of 0.9 pphm also occurred at the International Boundary site during January. The Montana 24-hour standard is 10 pphm. A comparison of sulphur dioxide concentrations with Class II Prevention of Significant Deterioration increments demonstrates that the 3-hour concentration is the averaging time which consumes the most increment. The 6.4 pphm 3-hour average at the International Boundary site would consume 33 percent of the available increment. All of the higher sulphur dioxide concentrations noted above occurred with northwest winds, indicating that the Saskatchewan Power Corporation generating facilities were the possible source.

The Montana and United States standards for total suspended particulates were not exceeded at any of the three monitoring sites. The highest 24-hour concentration was 110 ug/m^3 recorded on April 19, 1985, at the Richardson site. The International Boundary site recorded the highest geometric and arithmetic means at 26.5 and 29.6 ug/m^3, respectively. The levels of total suspended particulates observed during 1985 are low and representative of rural Montana.

Fine particulates in two size ranges were monitored at the International Boundary site and the Hanrahan site. Although there are presently no ambient standards for fine particulates, the U.S. Environmental Protection Agency has proposed standards for particulate matter with diameters less than 10 microns (PM-10). The proposal calls for an annual average in the range of 50-65 ug/m^3 and a 24-hour standard in the range of 150-250 ug/m^3. Montana did not actually sample the 10 micron and less category; however, the data from the less than 2.5 and less than 15 micron diameter categories provides a good indication that PM-10 levels would be in compliance with the proposed standards.

During 1985, the Montana Department of Health and Environmental Sciences continued to operate an extended network of lead dioxide sulfation plates in the Poplar River area. The sulfation plate network includes the existing three primary monitoring sites and five additional locations: the Microwave Tower, Flaxville, the TV Tower, Four Buttes, and Scobey Downtown. The objective of the sulfation plate network is to obtain a broad geographical indication of sulphur dioxide concentrations and to investigate the relationship between sulfation rate and sulphur dioxide concentrations. Montana anticipates that funding will not be available in the future for continuous sulphur dioxide monitoring. Therefore, Montana hopes that sulfation rate will prove to be an inexpensive substitute.

During 1985, the highest monthly sulfation rate was 0.10 milligram per 100 centimetres squared per day (mg/100 cm^2/day) at the Microwave Tower, International Boundary and Flaxville sites. These readings occurred during January and December. There does not appear to be a relationship between sulfation rate and sulphur dioxide at either the International Boundary or Hanrahan sites. However, concentrations were usually near the minimum detectable levels for both sampling methods and therefore any comparison between the data is very limited in usefulness.

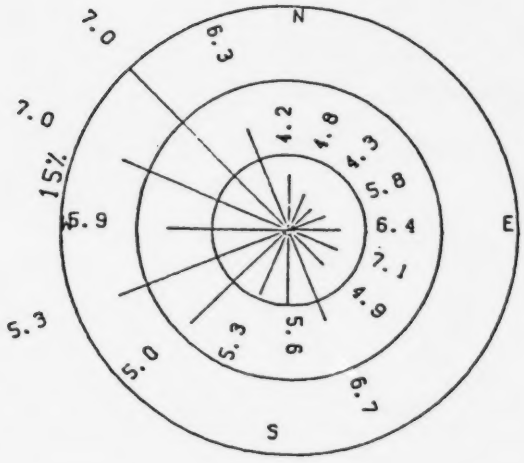
The State of Montana operated a meteorological system at the Hanrahan site from January through June, 1985. The quarterly wind roses for the site are displayed in Figure 10. The most prevalent winds as well as the strongest winds are from the west to the northwest.

SURFACE WIND ROSES

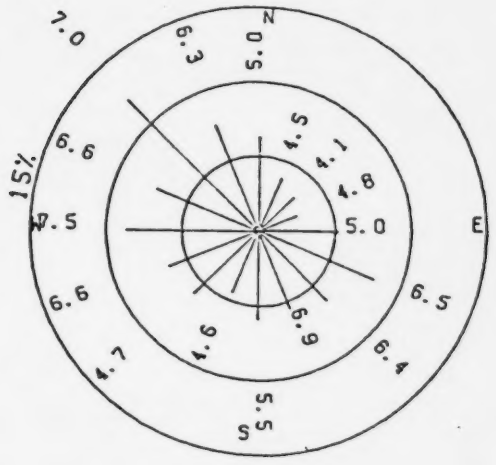
SITE: 340004

HANRAHAN RANCH

SCOBEY MONTANA



1/1/85 TO 3/31/85
HOURS 0 TO 23
CALM 0.0%
(TOTAL HOURS 2145)



4/1/85 TO 6/30/85
HOURS 0 TO 23
CALM 0.4%
(TOTAL HOURS 2017)

Figure 10 Surface Wind Roses

ANNEX 1

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

CANADA - UNITED STATES

September 23, 1980

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

I. PURPOSE

This Arrangement will provide for the exchange of data collected as described in the attached Technical Monitoring Schedules in water quality, water quantity and air quantity monitoring programs being conducted in Canada and the United States at or near the International Boundary in response to the Saskatchewan Power Corporation development. This Arrangement will also provide for the dissemination of the data in each country and will assure its comparability and assist in its technical interpretation.

The Arrangement will replace and expand upon the quarterly information exchange program instituted between Canada and the United States in 1976.

II. PARTICIPATING GOVERNMENTS

Governments and government agencies participating in the Arrangement are:

Government of Canada: Environment Canada
Government of the Province of Saskatchewan: Saskatchewan Environment
Government of the United States of America: U.S. Geological Survey
Government of the State of Montana: Executive Office

III. POPLAR RIVER MONITORING COMMITTEE: TERMS OF REFERENCE

A binational committee called the Poplar River Bilateral Monitoring Committee will be established to carry out responsibilities assigned to it under this Arrangement. The Committee will operate in accordance with the following terms of reference:

A. Membership

The Committee will be composed of four representatives, one from each of the participating Governments. It will be jointly chaired by the Government of Canada and the Government of the United States. There will be a Canadian Section and a United States Section. The participating Governments will notify each other of any changes in membership on the Committee. Cochairmen may by mutual agreement invite agency technical experts to participate in the work of the Committee.

The Governor of the State of Montana may also appoint a chief elective official of local government to participate as an ex-officio member of the Committee in its technical deliberations. The Saskatchewan Minister of the Environment may also appoint a similar local representative.

B. Functions of the Committee

The role of the Committee will be to fulfill the purpose of the Arrangement by ensuring the exchange of monitored data in accordance with the attached Technical Monitoring Schedules, and its collation and technical interpretation in reports to Governments on implementation of the Arrangement. In addition, the Committee will review the existing monitoring systems to ensure their adequacy and may recommend to the Canadian and United States Governments any modifications to improve the technical monitoring schedules.

1. Information Exchange

Each Cochairman will be responsible for transmitting to his counterpart Cochairman on a regular, and not less than quarterly basis, the data provided by the cooperative monitoring agencies in accordance with the Technical Monitoring Schedules.

2. Reports

(a) The Committee will prepare a joint Annual Report to the participating governments, and may at any time prepare joint Special Reports.

(b) Annual Reports will

i) summarize the main activities of the Committee in the year under Report and the data which has been exchanged under the Arrangement;

ii) draw to the attention of the participating governments any definitive changes in the monitored parameters, based on collation and technical interpretation of exchanged data (i.e. the utilization of summary, statistical and other appropriate techniques);

iii) draw to the attention of the participating governments any recommendations regarding the adequacy or redundancy of any scheduled monitoring operations and any proposals regarding modifications to the Technical Monitoring Schedules, based on a continuing review of the monitoring programs including analytical methods to ensure their comparability.

(c) Special Reports may, at any time, draw to the attention of participating governments definitive changes in monitored parameters which may require immediate attention.

(d) Preparation of Reports

Reports will be prepared following consultation with all committee members and will be signed by all Committee members. Reports will be separately forwarded by the Committee Cochairmen to the participating governments. All annual and special reports will be so distributed.

3. Activities of Canadian and United States Sections

The Canadian and United States section will be separately responsible for:

(a) dissemination of information within their respective countries, and the arrangement of any discussion required with local elected officials;

(b) verification that monitoring operations are being carried out in accordance with the Technical Monitoring Schedules by cooperating monitoring agencies;

(c) receipt and collation of monitored data generated by the cooperating monitoring agencies in their respective countries as specified in the Technical Monitoring Schedules;

(d) if necessary, drawing to the attention of the appropriate government in their respective countries any failure to comply with a scheduled monitoring function on the part of any cooperating agency under the jurisdiction of that government, and requesting that appropriate corrective action be taken.

IV. PROVISION OF DATA

In order to ensure that the Committee is able to carry out the terms of this Arrangement, the participating governments will use their best efforts to have cooperating monitoring agencies, in their respective jurisdictions provide on an ongoing basis all scheduled monitored data for which they are responsible.

V. TERMS OF THE ARRANGEMENT

The Arrangement will be effective for an initial term of five years and may be amended by agreement of the participating governments. It will be subject to review at the end of the initial term and will be renewed thereafter for as long as it is required by the participating governments.

ANNEX 2

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

1986

TECHNICAL MONITORING SCHEDULES

CANADA - UNITED STATES

May 1986

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PREAMBLE

The Technical Monitoring Schedule lists those water quantity, water quality and air quality monitoring locations and parameters which form the basis for information exchange and reporting to Governments. The structure of the Committee responsible for ensuring the exchange takes place is described in the Poplar River Cooperative Monitoring Arrangement.

The monitoring locations and parameters listed herein have been reviewed by the Poplar River Bilateral Monitoring Committee and represent the basic technical information needed to identify any definitive changes in water quantity, water quality and air quality at the International Boundary. The Schedule was initially submitted to Governments for approval as an attachment to the 1981 report to Governments. Changes in the sampling locations and parameters may be made by Governments based on the recommendations of the Committee.

Significant additional information is being collected by agencies on both sides of the International Boundary, primarily for project management or basin-wide baseline data purposes. This additional information is usually available upon request from the collecting agency and forms part of the pool of technical information which may be drawn upon by Governments for specific study purposes. Examples of additional information are water quantity, water quality, groundwater and air quality data collected at points in the Poplar River basin not of direct concern to the Committee. In addition, supplemental information on parameters such as vegetation, soils, fish and waterfowl populations and aquatic vegetation is also being collected on either a routine or specific studies basis by various agencies.

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1986

CANADA

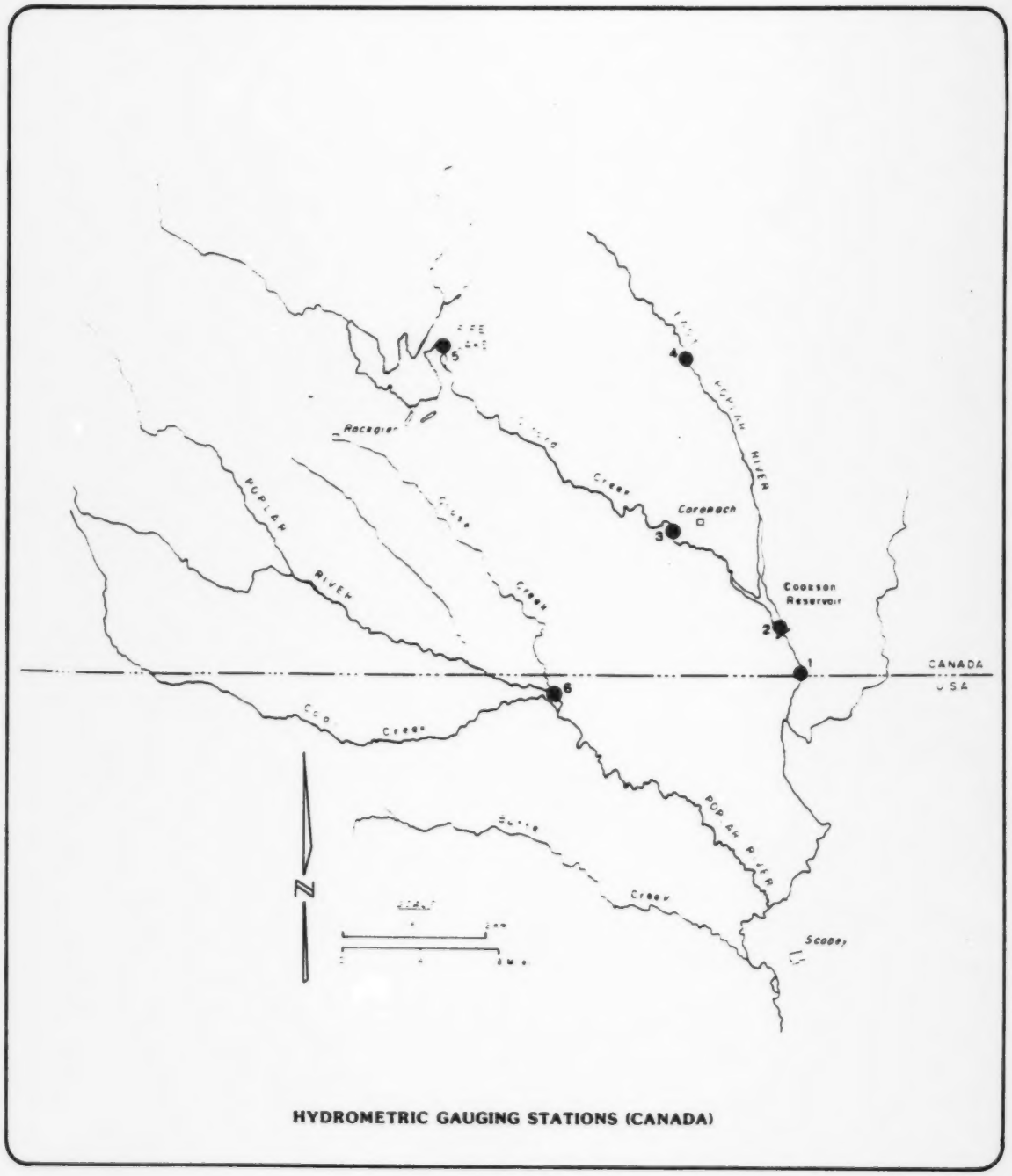
STREAMFLOW MONITORING

Responsible Agency: Environment Canada

Daily mean discharge or levels and instantaneous monthly extremes as normally published in surface water data publications.

No. on Map	Station No.	Station Name
1.	11AE003 (06178500)	East Poplar River at International Boundary
2.	11AE013	Cookson Reservoir near Coronach
3.	11AE015	Girard Creek near Coronach Cookson Reservoir
*4.	11AE014	East Poplar River above Cookson Reservoir
5.	**Fife Lake Overflow	
*6.	11AE008 (06178000)	Poplar River at International Boundary

* - International gauging station
** - Miscellaneous measurements of outflow to be made by Sask Water during periods of outflow only.



HYDROMETRIC GAUGING STATIONS (CANADA)

SURFACE WATER QUALITY MONITORING

Sampling Locations

Responsible Agency: Saskatchewan Environment

No. on Map	Station No.	Station Name
1	01SK02000002	Fife Lake Overflow
2**	00SK02000012	Girard Creek South of Town of Coronach
3**	05SK02000008	Upper End of Cookson Reservoir at Highway 36
4	05SK02000004	Cookson Reservoir near Dam
5	00SK02000003	East Poplar River at culvert immediately below Cookson Reservoir

Responsible Agency: Environment Canada

6	00SA11AE0008	East Poplar River at International Boundary

Parameters

Responsible Agency: Saskatchewan Environment

ESQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: 1	2	3	4	5
10151	Alkalinity-pheno	Pot. Titration	OF	Q	Q	Q	Q
10101	Alkalinity-tot	Pot. Titration	OF	Q	Q	Q	Q
13004	Aluminum tot	AA-direct		A	A	A	A
33004	Arsenic-tot	Flameless-A.A.		A	A	A	A
06201	Bicarbonates	Calculated	OF	Q	Q	Q	Q
05451	Boron-tot	ICPA	W	Q	Q	Q	Q
48002	Cadmium-tot	AA-Solvent extract (MIBK)		A	A	A	A
20103	Calcium	AA-Direct	OF	Q	Q	Q	Q
06052	Carbon-tot Inorg	IR	OF	Q	Q	Q	Q
06005	Carbon-tot Org	IR	OF	Q	Q	Q	Q
06301	Carbonates	Calculated	OF	Q	Q	Q	Q
17203	Chloride	Colourimetery	OF	Q	Q	Q	Q
06711	Chlorophyll 'a'	Colourimetery		Q	Q	Q	Q
24004	Chromium-tot	AA-direct		A	A	A	A
36012	Coliform-fec	MF	OF	Q	Q	Q	Q
36002	Coliform-tot	MF	OF	Q	Q	Q	Q
02041	Conductivity	Conductivity meter	W	Q	Q	Q	Q
29005	Copper-tot	AA-Solvent extract (MIBK)		A	A	A	A
09105	Flouride	Specific ion electrode		A	A	A	A
82002	Lead-tot	AA-Solvent extract (MIBK)		A	A	A	A
12102	Magnesium	AA-direct	OF	Q	Q	Q	Q
80011	Mercury-tot	Flameless AA		A	A	A	A
42005	Molybdenum	AA-Solvent Extract (MIBK)		A	A	A	A
07015	N-TKN	Colourimetry	OF	Q	Q	Q	Q
10401	NFR	Gravimetric	OF	Q	Q	Q	Q
10501	NFR (F)	Gravimetric	OF	Q	Q	Q	Q
28002	Nickel-tot	AA-Solvent extract (MIBK)	OF	Q	Q	Q	Q
07110	Nitrate + NO_2	Colourimetry	OF	Q	Q	Q	Q
06521	Oil and Grease	Pet. Ether Extraction		A	A	A	A
08102	Oxygen-diss	Meter	OF	Q	Q	Q	Q
15406	Phosphorus-tot	Colourimetry	OF	Q	Q	Q	Q
19103	Potassium	Flame Photometery	OF	Q	Q	Q	Q
34005	Selenium-Ext	Hydride Generation		A	A	A	A
11002	Sodium	Flame Photometry	OF	Q	Q	Q	Q
16306	Sulphate	Colourimetry	OF	Q	Q	Q	Q
10451	TDS	Gravimetric	OF	Q	Q	Q	Q
0206YZ	Temperature	Thermometer	OF	Q	Q	Q	Q
23004	Vanadium-tot	AA-Direct		A	A	A	A
30005	Zinc-tot	AA-Solvent extract (MIBK)		A	A	A	A
10301	pH	Electrometric	W	Q	Q	Q	Q

* Computer storage and retrieval system - Saskatchewan Environment

Symbols: W - Weekly during overflow; OF - once during each period of overflow greater than 2 weeks' duration; Q - quarterly; A - annually in the fall; AA - atomic absorption; IR - infrared; Pot - potentiometric; NFR - nonfilterable residue NFRF - nonfilterable residue, fixed.

AA - Solvent Extract (MIBK): Sample digested with HNO_3 and extracted with methyl isobutyl ketone.

ICPA - Plasma emmission

MF - membrane filtration

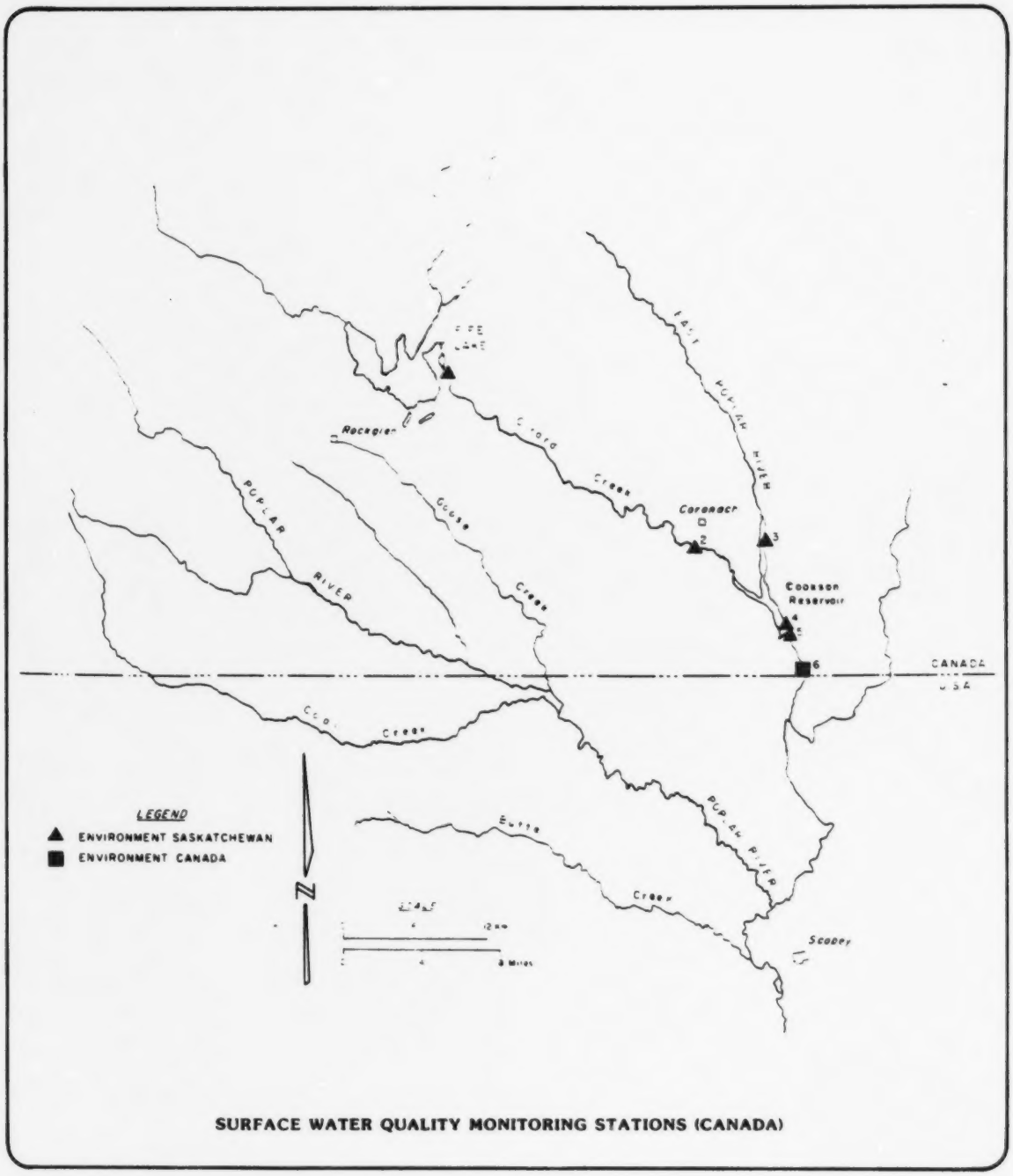
** Location under review in 1986.

PARAMETERS (Continued)

Responsible Agency: Environment Canada

NAQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: 6
10151	Alkalinity-pheno	Potentiometric	M
10111	Alkalinity-tot	Titroprocessor	M
13102	Aluminum-Diss.	AA-Direct	M
07569	Ammonia-Free	Calculated	M
07506	Ammonia-tot	Electrometric	M
33108	Arsenic-diss	Plasma	M
56001	Barium-tot	AA Direct	M
06201	Bicarbonates	Calculated	M
05105	Boron-diss	Carminic Acid	M
48002	Cadmium-tot	AA Solv. Ext.	M
20103	Calcium	AA-Direct	M
06902	Carbon-partic	Elemental Analyzer	M
06002	Carbon-tot Org	Calculated	M
06301	Carbonates	Calculated	M
17206	Chloride	Colourimetric	M
06717	Chlorophyll a	Spectrophotometric	M
24003	Chromium-tot	AA-Solv. Ext.	M
27002	Cobalt-tot	AA Solv. Ext.	M
36012	Coliform-fec	MF	M
36002	Coliform-tot	MF	M
02021	Colour - true	Comparator	M
02041	Conductivity	Wheatstone Bridge	M
29005	Copper-tot	AA-Solv. Ext.	M
06604	Cyanide	UV-Colourimetric	M
09106	Fluoride	Electrometric	M
10602	Hardness	Calculated	M
08501	Hydroxide	Calculated	M
26104	Iron-diss	AA-direct	M
82002	Lead-tot	AA-Solv. Ext.	M
12102	Magnesium	AA-direct	M
25104	Manganese-diss	AA-direct	M
80011	Mercury-tot	Flameless AA	M
07902	N-particulate	Elemental Analyzer	M
07651	N-tot diss	UV Colourimetric	M
10401	NFR	Gravimetric	M
28002	Nickel-tot	AA-Solv. Ext.	M
07110	Nitrate	Colourimetric	M
07603	Nitrogen-tot	Calculated	M
180XX	Organo Chlorines	GC	M
08101	Oxygen-diss	Winkler	M
15901	P-particulate	Calculated	M
15103	P-tot diss	Colourimetric	M
06535	Phenolics	Colourimetric	M
185XX	Phenoxy Herbicides	GC	M
15406	Phosphorus-tot	Colourimetric	M
19103	Potassium	Flame Emission	M
18599	Picloram	GC	M
11201	Percent Sodium	Calculated	M
00210	Sat Index	Calculated	M
34102	Selenium-diss	Plasma	M
14102	Silica	Colourimetric	M
11103	Sodium	Flame Emission	M
00211	Stab Index	Calculated	M
16306	Sulphate	Colourimetric	M
00201	TDS	Calculated	M
02061	Temperature	Alcohol	M
02073	Turbidity	Nephelometric	M
23002	Vanadium-tot	AA-Solv. Ext.	M
30002	Zinc-tot	AA-Solv. Ext.	M
10301	pH	Electrometric	M
92111	Uranium	Flurometric	MC

*Computer storage and retrieval system - Environment Canada
Symbols: M-Monthly; AA-atomic absorption; MF-membrane filtration; UV-ultraviolet; NFR-nonfilterable residue; GC-gas chromatography; MC-Monthly Composite;



SURFACE WATER QUALITY MONITORING STATIONS (CANADA)

GROUND WATER QUALITY MONITORING

Sampling Locations

Responsible Agency: Saskatchewan Environment

Station	SPC Piezometer No.	Station Description: Sampling Elevation (m)	Station Description: Material
8a	C726A	746.338	unoxidized till
	C726C	752.739	oxidized till
	C726D	755.543	oxidized till
8a	C726E	738.725	empress gravel
9a	C728A	753.405	oxidized till
	C728B	743.265	unoxidized till
	C728C	747.645	mottled till
	C728D	752.305	oxidized till
9a	C728E	739.912	empress gravel
2a	C712B	746.112	oxidized till
2b	C718	748.385	mottled till
2c	C719	747.715	oxidized till
C533	C533	740.441	empress gravel
C534	C534	753.499	till
18	C741	735.153	empress gravel
19	C735	753.789	empress gravel
21	C742	741.800	empress gravel

Parameters

Responsible Agency: Saskatchewan Environment

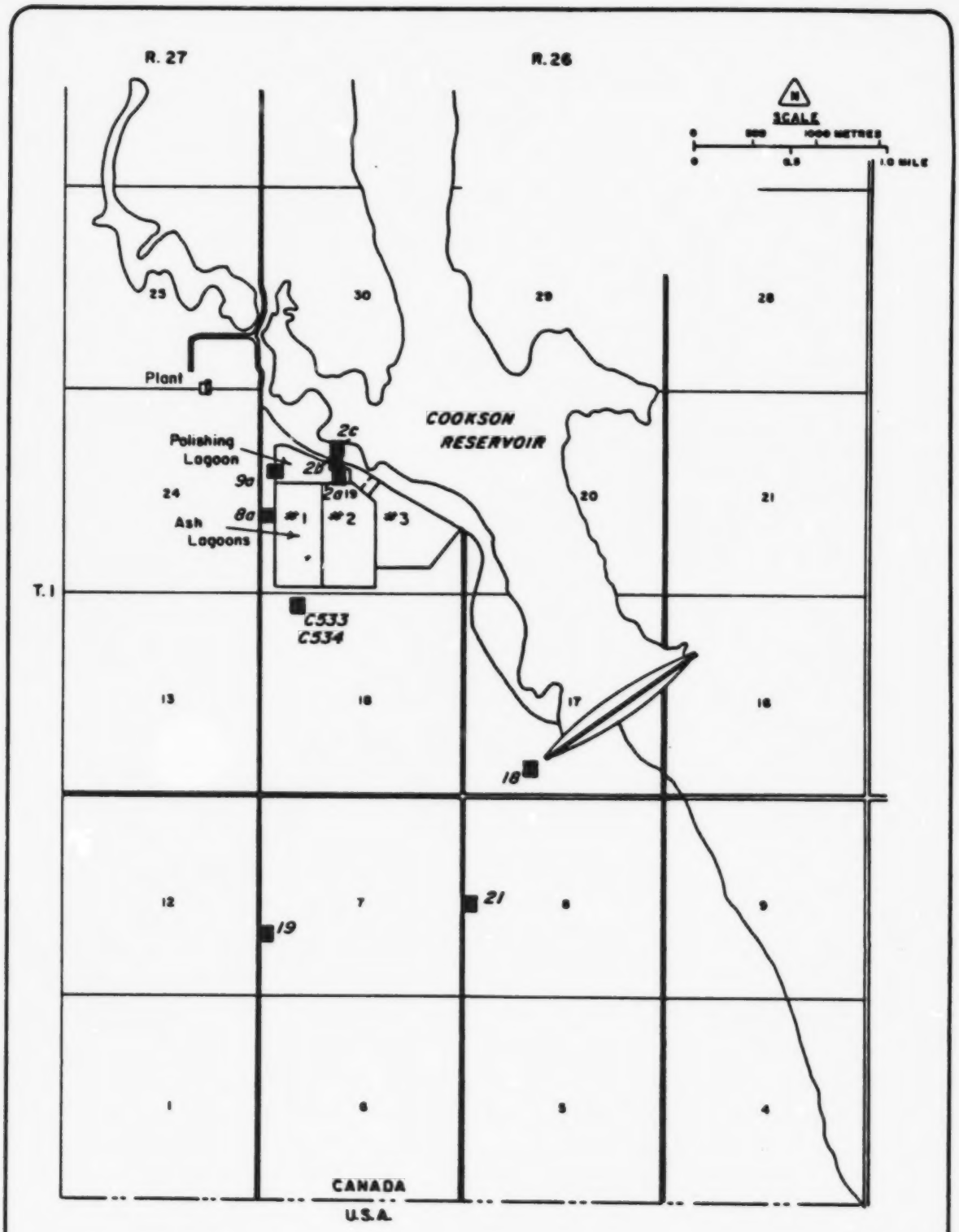
ESQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No: Piezometers
10101	Alkalinity-tot	Pot-Titration	A
13105	Aluminum-Diss	AA-Direct	3
33104	Arsenic-Diss	Flameless AA	A
56104	Barium-Diss	AA-Direct	A
06201	Bicarbonates	Calculated	A
05106	Boron-diss	Colourimetry	3
48102	Cadmium-Diss	AA-Solvent Extract (MIBK)	A
20103	Calcium-Diss	AA-direct	A
06301	Carbonates	Calculated	A
17203	Chloride-Diss	Colourimetry	A
24104	Chromium-Diss	AA-Direct	A
27102	Colbalt-Diss	AA-Solvent Extract (MIBK)	A
02011	Colour	Comparator	A
02041	Conductivity	Conductivity meter	3
29105	Copper-Diss	AA-Solvent Extract (MIBK)	A
09105	Fluoride-Diss	Specific Ion Electrode	A
26014	Iron-Diss	AA-Direct	A
82103	Lead-Diss	AA-Solvent Extract (MIBK)	A
			A
12102	Magnesium-Diss	AA-Direct	A
25104	Manganese-Diss	AA-Direct	A
80111	Mercury-Diss	Flameless AA	A
42102	Molybdenum-Diss	AA-Solvent extract (N-Butyl acetate)	A
			A
			A
10301	pH	Electrometric	3
19103	Potassium-Diss	Flame Photometry	A
34105	Selenium-Diss	Hydride generation	A
14102	Silica-Diss	Colourimetry	A
11103	Sodium-Diss	Flame Photometry	A
38101	Strontium-Diss	AA-Direct	3
16306	Sulphate-Diss	Colourimetry	3
10451	TDS	Gravimetric	3
92111	Uranium-Diss	Fluorometry	3
23104	Vanadium-Diss	AA-Direct	A
97025	Water Level		A
30105	Zinc-Diss	AA-Solvent Extract (MIBK)	A

No zinc or iron for piezometers C533 or C534

* Computer Storage and Retrieval System - Saskatchewan Environment

Symbols: AA - atomic absorption. A - Annually. 3 - Three times per year

AA-Solvent Extract (MIBK): sample acidified and extracted with Methyl Isobutyl Ketone



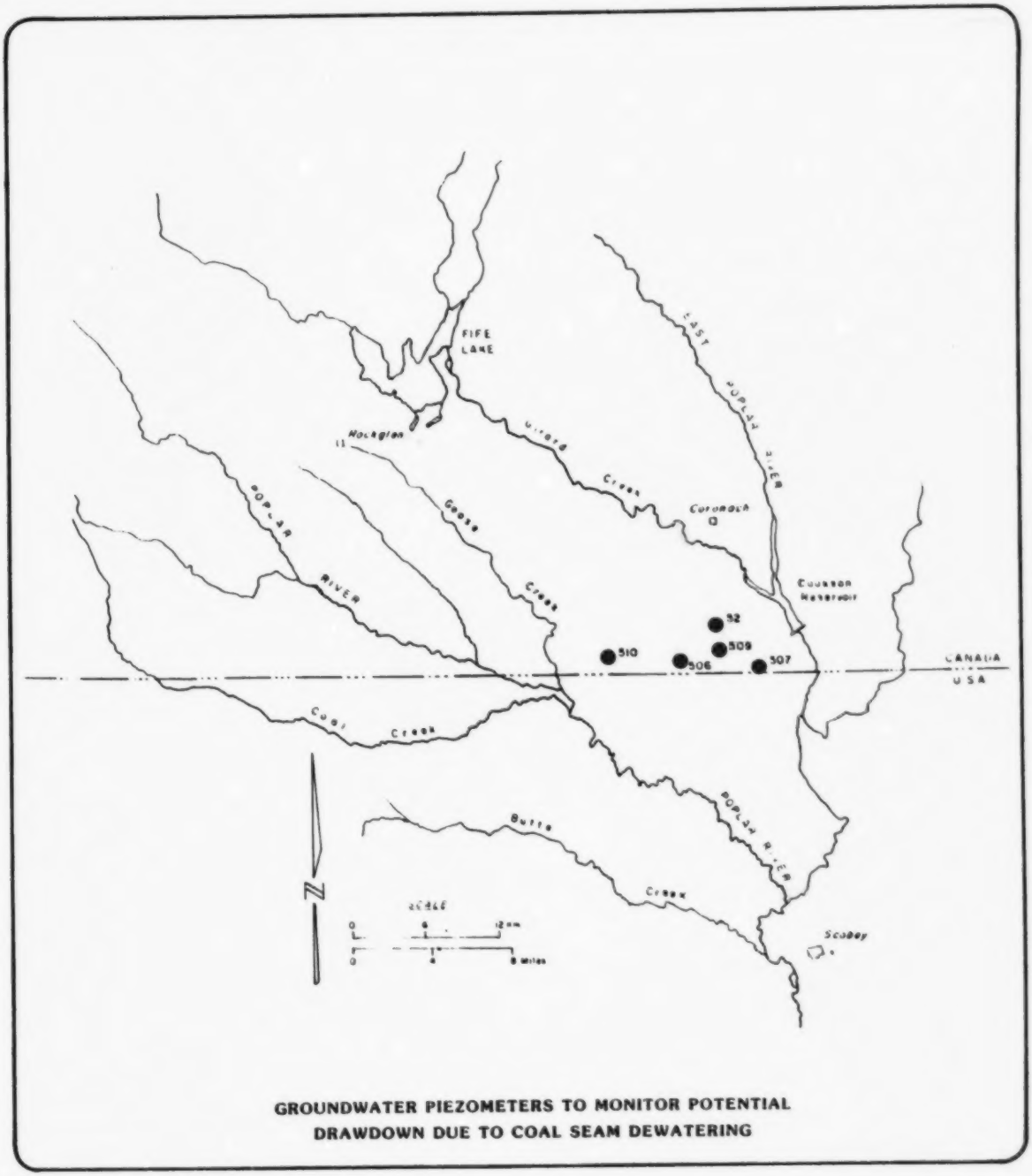
GROUND WATER QUALITY MONITORING (CANADA)

GROUND WATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

Responsible Agency: Saskatchewan Water Corporation

Measurement Frequency: Quarterly

SPC Piezometer No.	Station Number	Location	Sampling Elevation (m)	Perforation Zone (depth in metres)
52	52	NW14-1-27W3	738.43	43 - 49 (in coal)
506	506A	SW4-1-27W3	748.27	81 - 82 (in coal)
507	507	SW6-1-26W3	725.27	34 - 35 (in coal)
509	509	NW11-1-27W3	725.82	76 - 77 (in coal)
510	510	NW1-1-28W3	769.34	28 - 29 (in layered coal and clay)



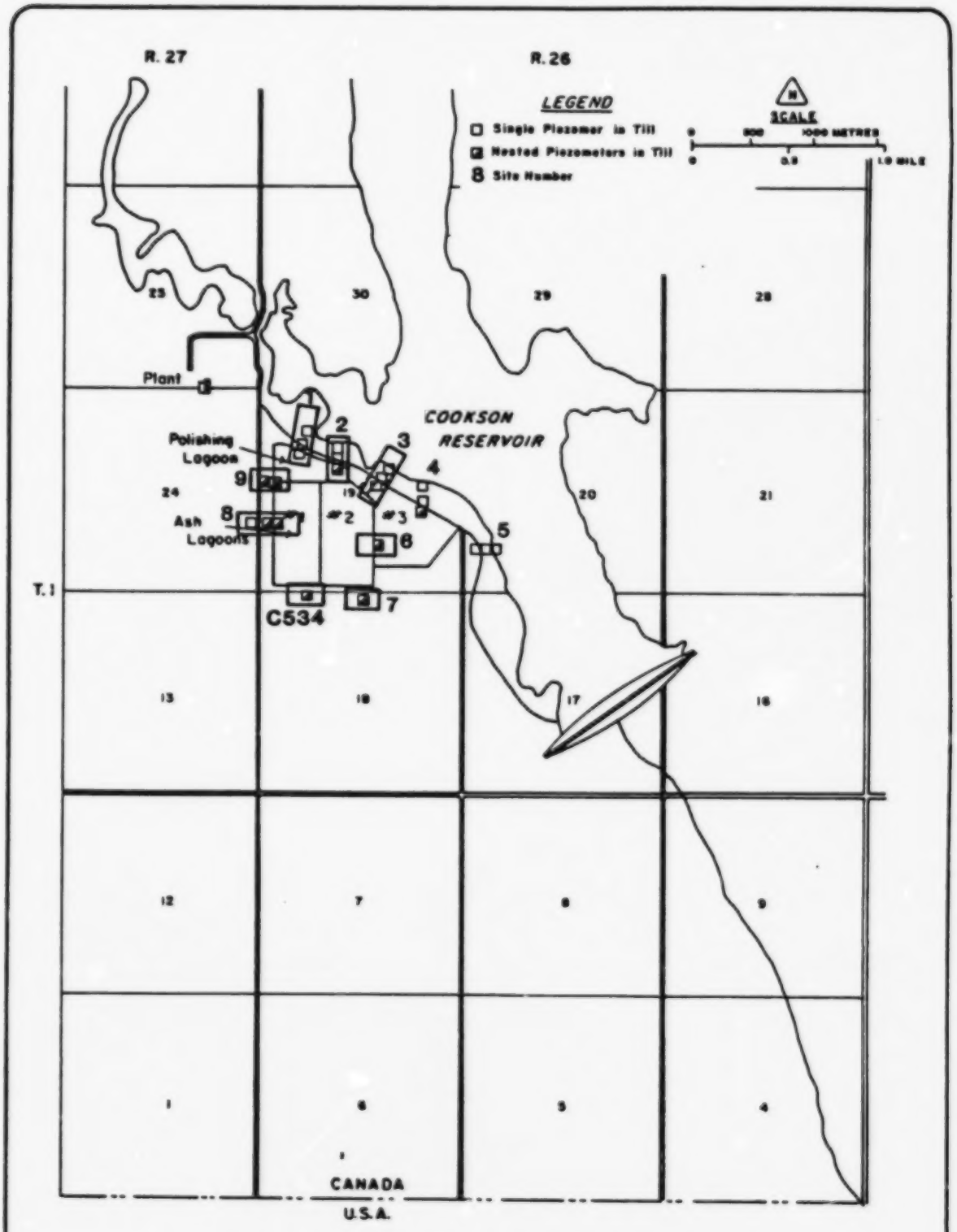
GROUNDWATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

GROUND WATER PIEZOMETER LEVEL MONITORING - ASH LAGOON AREA

SCHEDULE A - PIEZOMETERS IN TILL

Responsible Agency: Saskatchewan Environment

Station	SPC Piezometer No.	Frequency of Measurement
1a	C716	All piezometer levels are measured quarterly
1b	C717	
1c	C711	
$2a_1$	C712A	
$2a_2$	C712B	
$2a_3$	C712C	
$2a_4$	C712D	
2b	C718	
2c	C719	
3a	C713	
3b	C720	
3c	C721	
$6a_1$	C763A	
$6a_2$	C763B	
$6a_3$	C763C	
$6a_4$	C763D	
$7a_1$	C729A	
$7a_2$	C729B	
$7a_3$	C729C	
$7a_4$	C729D	
C534	C534	
$8a_1$	C730A	
$8a_2$	C730B	
$8a_3$	C730C	
$8a_4$	C730D	
$8b_1$	C727A	
$8b_2$	C727B	
$8b_3$	C727C	
$8c_1$	C726A	
$8c_2$	C726B	
$8c_3$	C726C	
$8c_4$	C726D	
8d	C748	
$9a_1$	C764A	
$9a_2$	C764B	
$9a_3$	C764C	
$9a_4$	C764D	
$9b_1$	C728A	
$9b_2$	C728B	
$9b_3$	C728C	
$9b_4$	C728D	



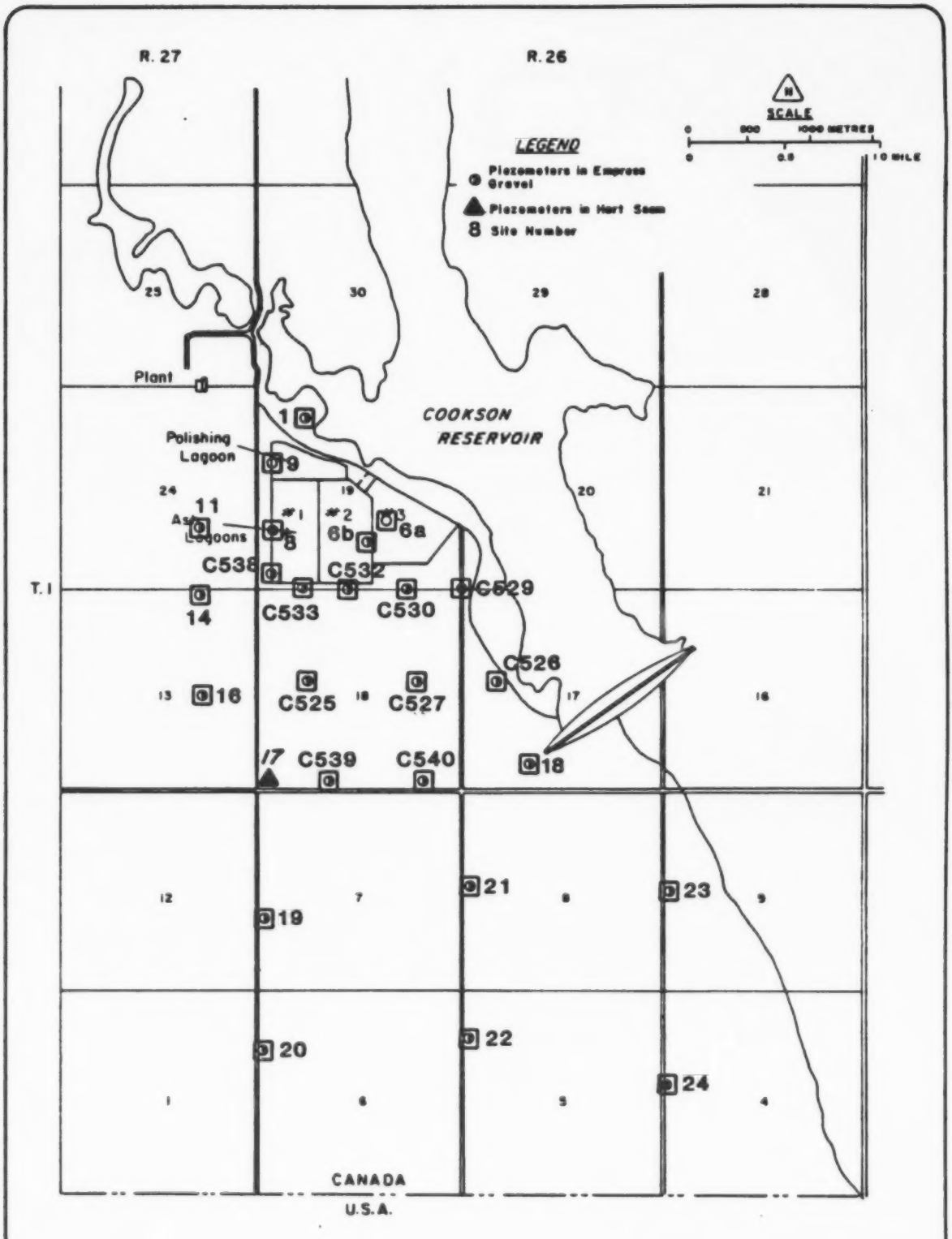
PIEZOMETER INSTALLATION SITES - SCHEDULE "A" PIEZOMETERS IN TILL

GROUND WATER PIEZOMETER LEVEL MONITORING - ASH LAGOON AREA AND INTERNATIONAL BOUNDARY AREA

SCHEDULE B - PIEZOMETERS IN EMPRESS GRAVEL

Responsible Agency: Saskatchewan Environment

Station Immediate Ash Lagoon Area	SPC Piezometer No.	Frequency of Measurement
1	C731	All piezometers are monitored quarterly
6a	C763E	
6b	C765A	
C529	C529	
C530	C530	
C532	C532	
C533	C533	
C538	C538	
8	C730E	
9	C728E	
West of Ash Lagoon Area		
11	C743	
14	C740	
16	C756	
South of Ash Lagoon Area		
C525	C525	
C526	C526	
C527	C527	
C539	C539	
C540	C540	
18	C741	
19	C735	
20	C736	
21	C742	
22	C733	
23	C732	
24	C734	



PIEZOMETER INSTALLATION SITES - SCHEDULE "B" PIEZOMETERS IN EMPRESS GRAVEL

AMBIENT AIR QUALITY MONITORING

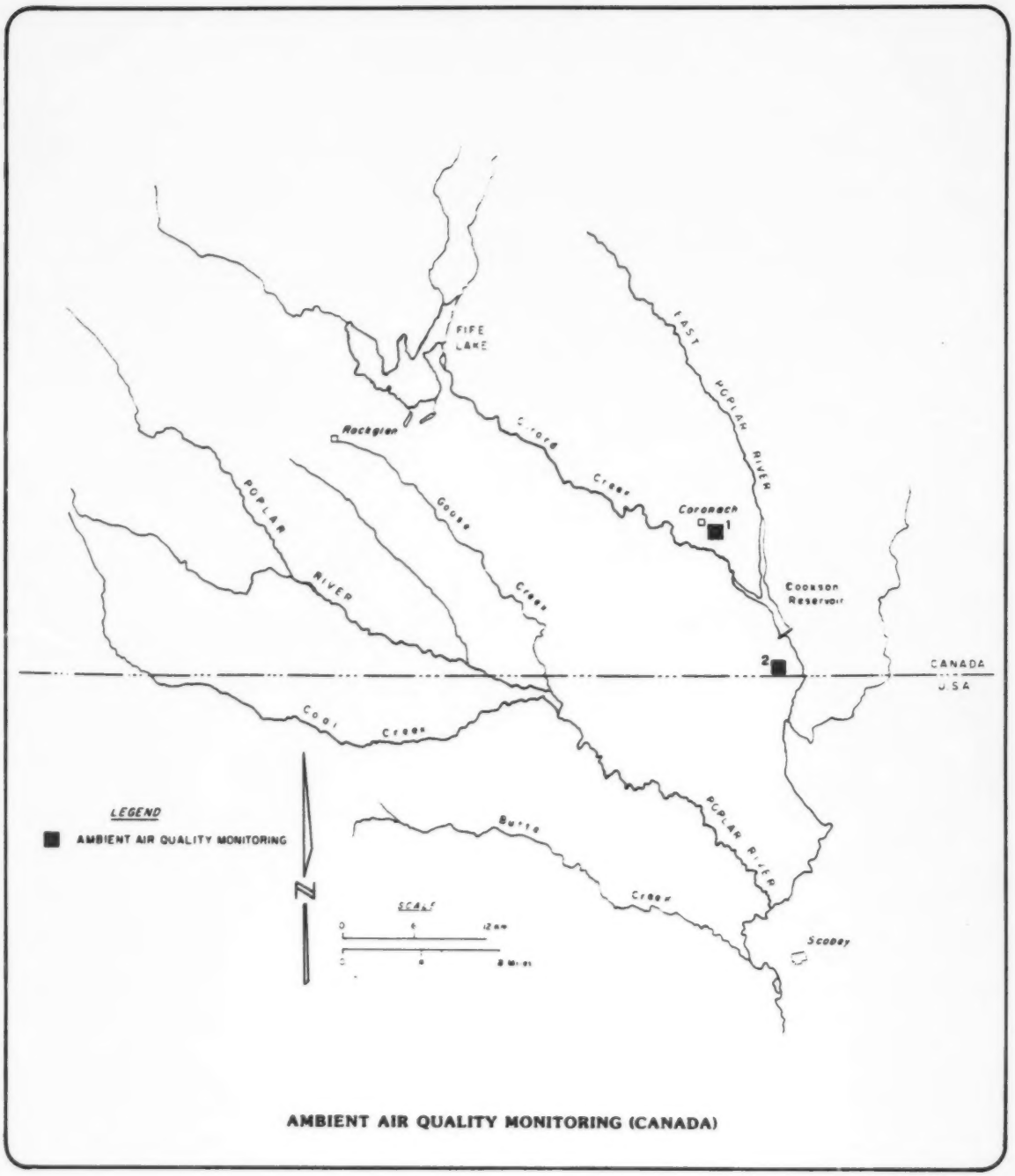
Responsible Agency: Saskatchewan Environment

No. on Map	Location	Parameters	Reporting Frequency
1	Coronach	Sulphur Dioxide	Continuous monitoring with hourly averages as summary statistics.
		Wind speed and direction	Continuous monitoring with hourly averages as summary statistics
		Total Suspended Particulates	24-hour samples on a 6-day cycle; corresponding to the National Air Pollution Surveillance Sampling Schedule.
2	International Boundary*	Sulphur Dioxide	Continuous monitoring with hourly averages as summary statistics
		Total Suspended Particulates	24-hour samples on 6-day cycle, corresponding to the National Air Pollution Surveillance Sampling Schedule.

METHODS

Sulphur Dioxide	Saskatchewan Environment Colourimetric Titration, Pulsed Fluorescence
Total Suspended Particulates	Saskatchewan Environment High Volume Method

* The station operated by Saskatchewan Power



AMBIENT AIR QUALITY MONITORING (CANADA)

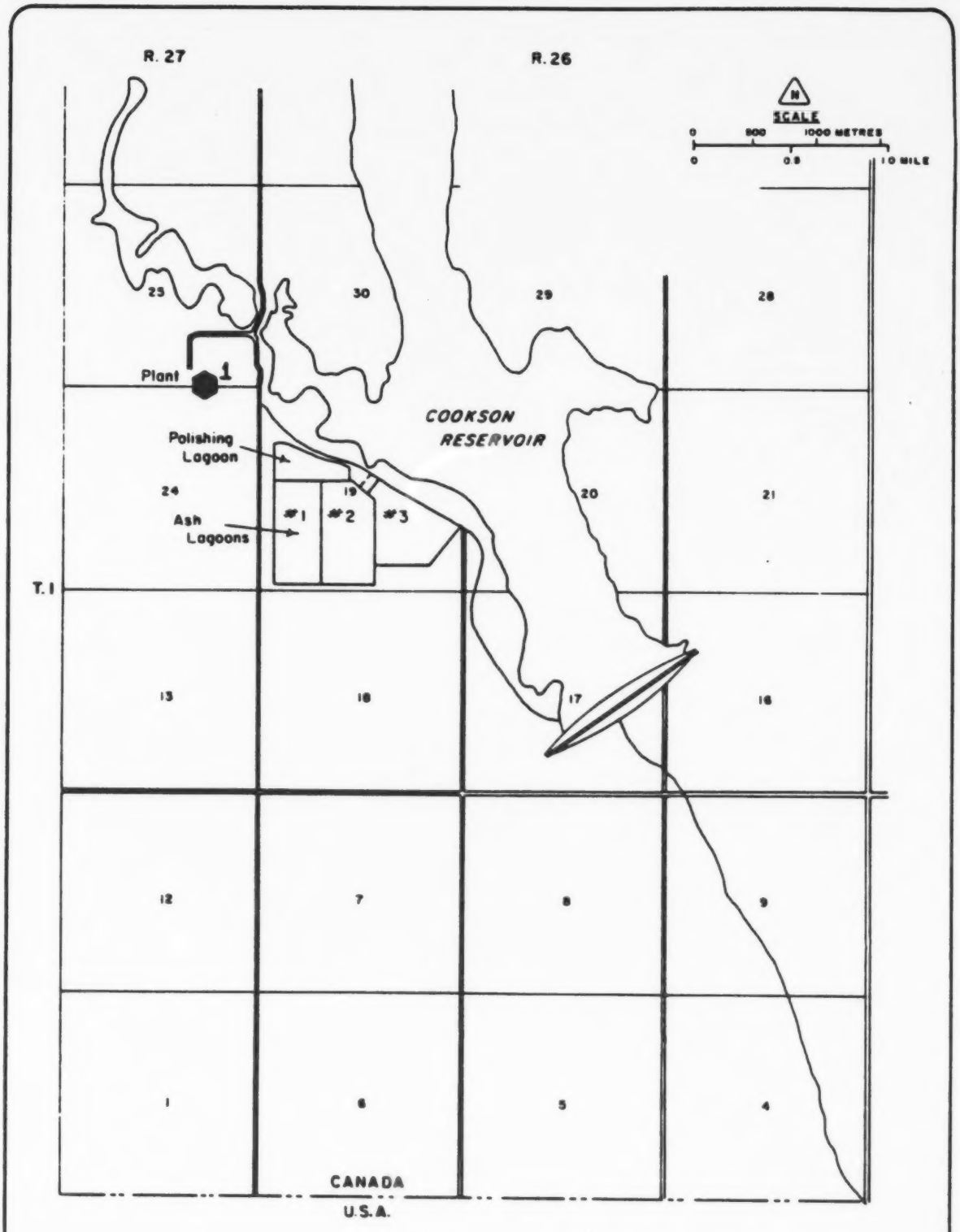
SOURCE EMISSION MONITORING

Responsible Agency: Saskatchewan Environment

No. on Map	Station Location	Parameters	Sampling Frequency
1	At Poplar River Power Plant	Sulphur Dioxide Nitrogen Dioxide, Opacity.	Continuous reported as Hourly Averages

METHODS

Sulphur Dioxide	Saskatchewan Environment - Ultraviolet Absorption
Nitrogen Dioxide	Saskatchewan Environment - Chemiluminescence
Opacity	Saskatchewan Environment - Optical



SOURCE EMISSION MONITORING

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1986

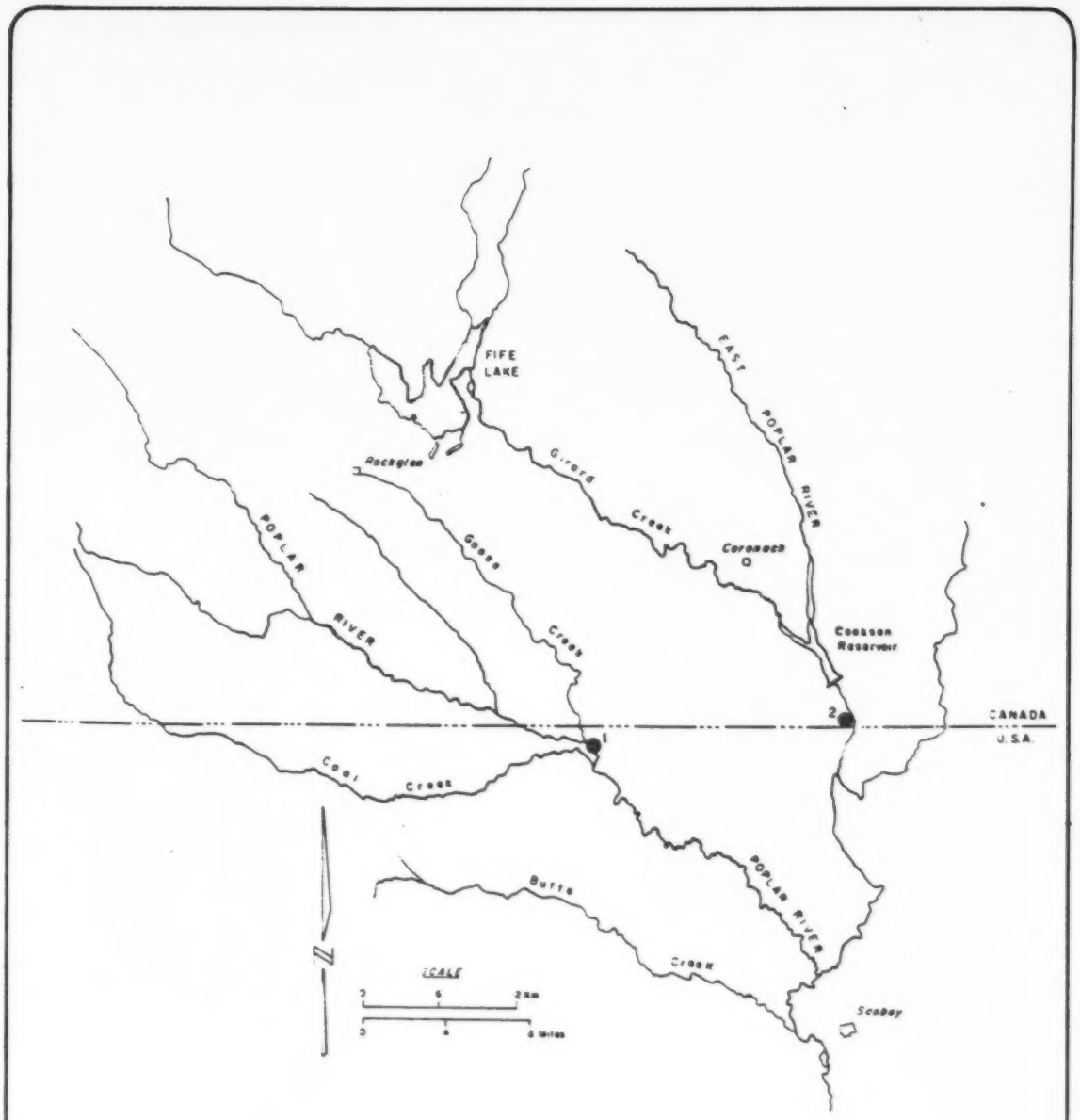
UNITED STATES

STREAMFLOW MONITORING

Responsible Agency: United States Geological Survey

No. on Map	Station Number	Station Name
*1	06178000 (11AE008)	Poplar River at International Boundary
*2	06178500 (11AE003)	East Poplar River at International Boundary

* International gauging station



HYDROMETRIC GAUGING STATIONS (UNITED STATES)

SURFACE WATER QUALITY MONITORING

Station Location

Responsible Agency: U.S. Geological Survey

No. on Map	USGS Station No.	Station Name
1	06178000	Poplar River at International Boundary
2	06178500	East Poplar River at International Boundary
3	06179000	East Poplar River near Scobey

PARAMETERS

WATSTORE* Code	Parameter	Analytical method	Sampling Frequency No.	1	2	3
90410	Alkalinity-lab	Elect. Titration		M	M	M
01106	Aluminum-diss	AA		SA	SA	SA
00610	Ammonia-tot	Colorimetric		M	M	M
00625	Ammonia+Org N-tot	Colorimetric		M	M	M
01000	Arsenic-diss	AA, hydride		SA	SA	SA
01002	Arsenic-tot	AA, hydride		A	A	A
01010	Beryllium-diss	AA		SA	SA	SA
01012	Beryllium-tot/rec	AA-Persulfate		A	A	A
01020	Boron-diss	ICP		M	M	M
01025	Cadmium-diss	AA		SA	SA	SA
01027	Cadmium-tot/rec	AA-persulfate		A	A	A
00915	Calcium	AA		M	M	M
00680	Carbon-tot Org	Wet Oxidation		SA	SA	SA
00940	Chloride-diss	Ion chromatography		M	M	M
01030	Chromium-diss	AA		SA	SA	SA
01034	Chromium-tot/rec	AA-persulfate		A	A	A
00080	Color	Electrometric, visual		M	M	M
00095	Conductivity	Wheatstone Bridge		M	D	M
01040	Copper-diss	AA		SA	SA	SA
01042	Copper-tot/rec	AA-persulfate		A	A	A
00061	Discharge-inst	Direct measur.		M	M	M
00950	Fluoride	Electrometric		M	M	M
01046	Iron-diss	AA		M	M	M
01045	Iron-tot/rec	AA-persulfate		A	A	A
01049	Lead-diss	AA		SA	SA	SA
01051	Lead-tot/rec	AA-persulfate		A	A	A
00925	Magnesium-diss	AA		M	M	M
01056	Manganese-diss	AA		SA	SA	SA
01055	Manganese-tot/rec	AA-persulfate		A	A	A
01065	Nickel-diss	AA		SA	SA	SA
01067	Nickel tot/rec	AA-persulfate		A	A	A
00615	Nitrite-tot	Colorimetric		M	M	M
00630	Nitrate+Nitrite-tot	Colorimetric		M	M	M
00300	Oxygen-diss	Winkler/meter		M	M	M
70507	Phos, Ortho-tot	Colorimetric		M	M	M
00400	pH	Electrometric		M	M	M
00665	Phophorous-tot	Colorimetric		M	M	M
00935	Potassium-diss	AA		M	M	M
00931	SAR	Calculated		M	M	M
80154	Sediment-conc.	Filtration-gravimetric		M	M	M
80155	Sediment-load	Calculated		M	M	M
01145	Selenium-diss	AA, hydride		SA	SA	SA
01147	Selenium tot/rec	AA, hydride		A	A	A
00955	Silica	Colorimetric		M	M	M
00930	Sodium	AA		M	M	M
00945	Sulfate-diss	Colorimetric		M	M	M
70301	Total Dissolved Solids	Calculated		M	M	M
00010	Temp Water	Toluene		M	M	M
00020	Temp Air	Toluene		M	M	M
00076	Turbidity	Nephelometric		M	M	M
80020	Uranium-diss	Fluorimetric		-	MC	-
01090	Zinc-diss	AA		SA	SA	SA
01092	Zinc-tot/rec	AA-persulfate		A	A	A

*Computer storage and retrieval system - USGS

Symbols: C-continuous; D-daily; M-monthly; MC-monthly composite; A-annually at high flow; SA-semi-annually at low and high flow; AA-atomic absorption; tot-total; rec-recoverable; diss-dissolved

SURFACE WATER QUALITY MONITORING STATIONS (UNITED STATES)

GROUND WATER QUALITY MONITORING

Station Locations

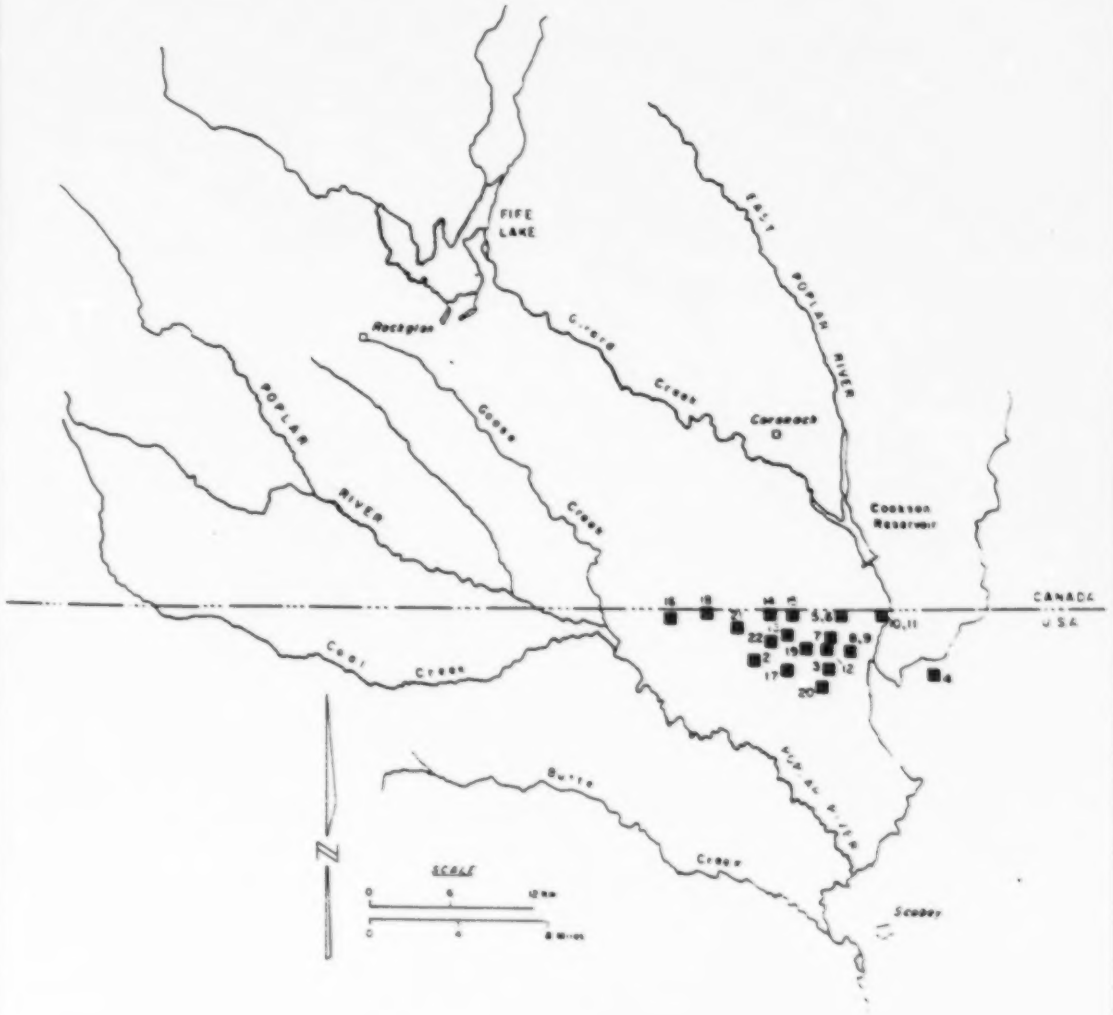
Responsible Agency: Montana Bureau of Mines and Geology

Map Number	Well Location	Total Depth (m)	Casing Diameter (cm)	Aquifer	Perforation Zone (m)
2	37N47E17DABB	79	3.8 PVC	Hart Coal	76-79
3	37N47E23AADD	36	3.8 PVC	Hart Coal	33-36
4	37N48E23BBCC	104	3.8 PVC	Fox Hills-Hell Creek	102-104
5	37N47E1ABBB1	16	10.2 PVC	Alluvium	10-15
6	37N47E1ABBB2	25	10.2 PVC	Hart Coal	19-25
7	37N47E12BBBB	45	10.2 PVC	Hart Coal	39-45
8	37N47E13AADD	14	10.2 PVC	Alluvium	10-13
9	37N47E13ADAA01	43			
		63	10.2 PVC	Fort Union	16-62
10	37N48E5BABB	13	10.2 PVC	Alluvium-Coal	7-13
11	37N48E5AAAA	67	15.2 STEEL	Fox Hills-Hell Creek	65-67
12	37N47E Sec 11 DDDD	26	5.08	Hart Coal	15-18
13	37N47E Sec 3 CCCC	62.5	10.2	Hart Coal	56-59
14	37N47E Sec 4 BBAB	82.6	10.2	Hart Coal	75-78
15	37N47E Sec 3 BBAA	89	10.2	Hart Coal	83-86
16	37N46E Sec 3 ABAB	26	10.2		24-25
17	37N47E Sec 16 DDDD	88	10.6	Hart Coal	80-83
18	37N46E Sec 1 BBBA	90	10.2	Hart Coal	80-82
19	37N47E Sec 15 AAAB	59	10.2	Hart Coal	54-56
20	37N47E Sec 24 CCCC	22	5.08		19-22
21	37N47E Sec 6 DBAA	106	10.2	Hart Coal	100-103
22	37N47E Sec 9 CBCC	21	10.2		18-21

Parameters

Storet* Code	Parameter	Analytical Method	Sampling Frequency Station No.
00440	Bicarbonates	Electrometric Titration	Sample collection is semi-annually for all locations identified above.
01020	Boron-diss	Emission Plasma ICP	
00915	Calcium	Emission Plasma	
00445	Carbonates	Electrometric Titration	The analytical method descriptions are those of the Montana Bureau of Mines and Geology Laboratory where the samples are analyzed.
00940	Chloride	Ion Chromatography	
00095	Conductivity	Wheatstone Brdg	
01040	Copper-diss	Emission Plasma, ICP	
00950	Fluoride	Ion Chromatography	
01046	Iron-diss	Emission Plasma, ICP	
01049	Lead-diss	Emission Plasma, ICP	
01130	Lithium-diss	Emission Plasma, ICP	
00925	Magnesium	Emission Plasma, ICP	
01056	Manganese-diss	Emission Plasma, ICP	
01060	Molybdenum	Emission Plasma, ICP	
00630	Nitrate	Ion Chromatography	
00400	pH	Electrometric	
00935	Potassium	Emission Plasma, ICP	
01145	Selenium-diss	AA	
00955	Silica	Emission Plasma, ICP	
00930	Sodium	Emission Plasma, ICP	
01080	Strontium-diss	Emission Plasma, ICP	
00445	Sulphate	Ion Chromatography	
22703	Uranium	Fusion Flurometric	
00190	Zinc-diss	Emission Plasma, ICP	
70301	TDS	Calculated	

*Computer storage and retrieval system - United States Geological Survey
Symbols: AA-Atomic Absorption; ICP-Inductively Coupled Plasma Unit



GROUND WATER QUALITY MONITORING (UNITED STATES)

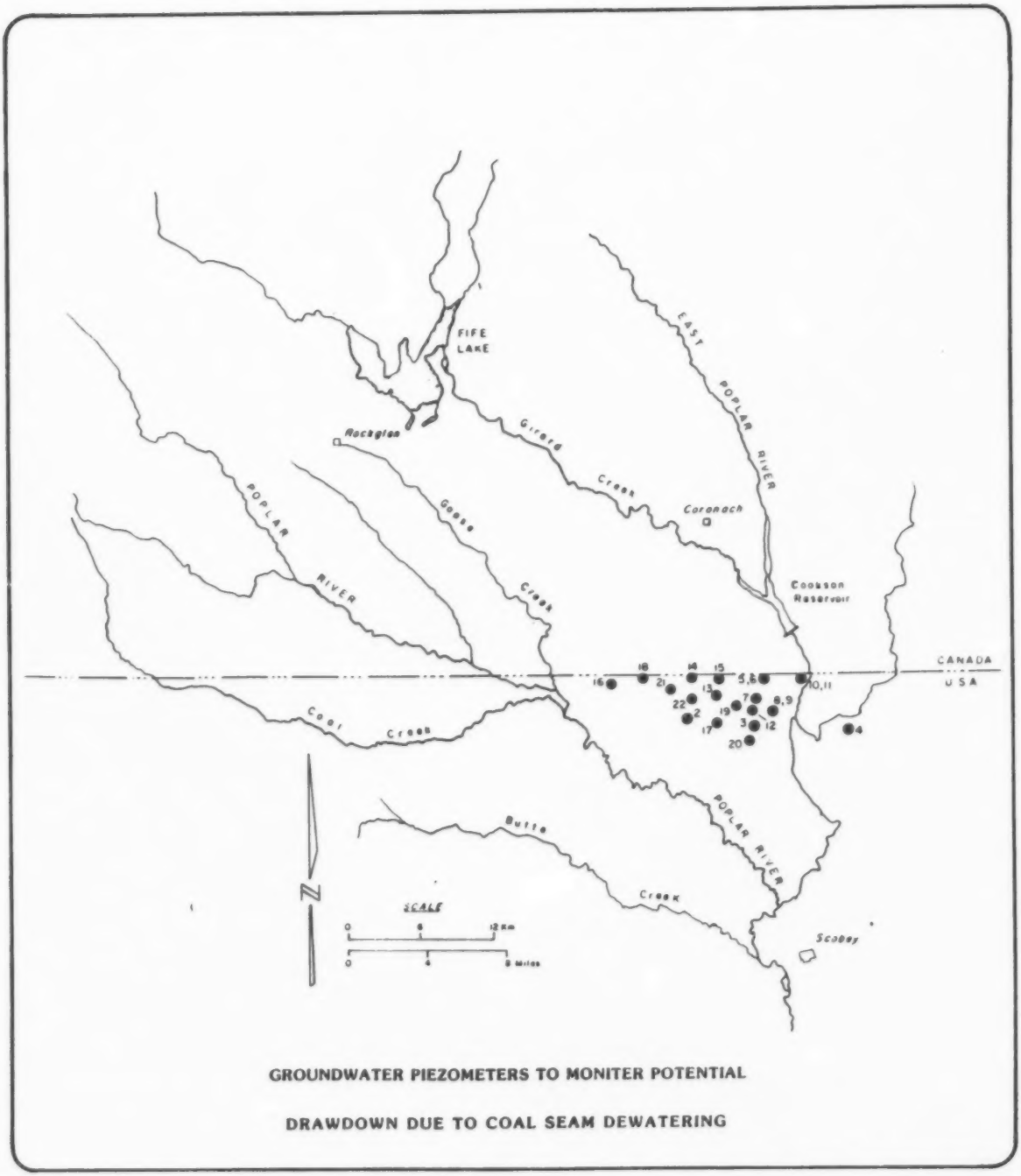
GROUND WATER LEVELS TO MONITOR

POTENTIAL DRAWDOWN DUE TO

COAL SEAM DEWATERING

Responsible Agency: Montana Bureau of Mines and Geology

No. on Map	Sampling
2 to 22	Determine water levels quarterly



GROUNDWATER PIEZOMETERS TO MONITER POTENTIAL

DRAWDOWN DUE TO COAL SEAM DEWATERING

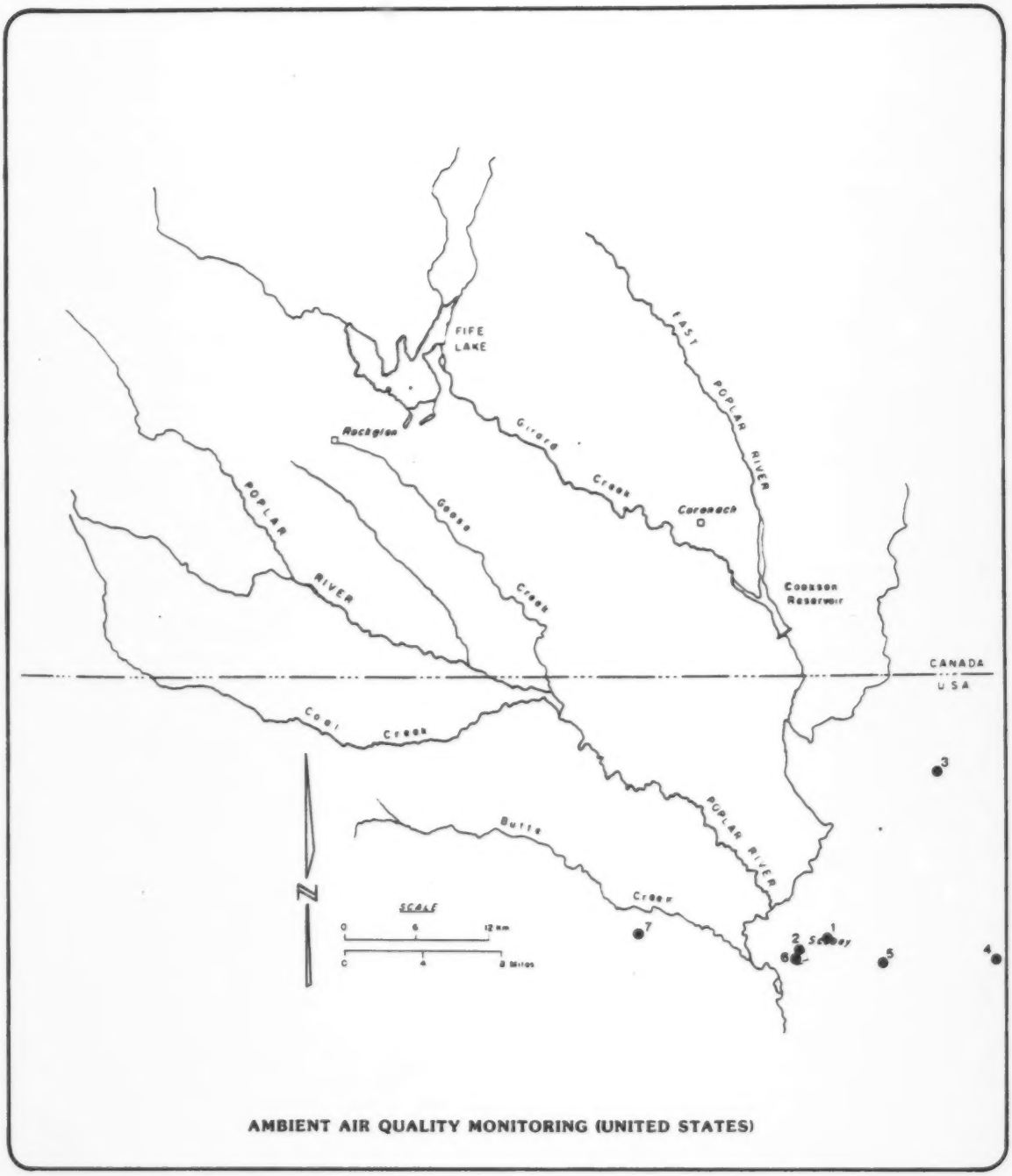
AMBIENT AIR QUALITY MONITORING

Responsible Agency: State of Montana
Air Quality Bureau

No. on Map	Location	Parameters	Sampling Frequency and Reporting
1	Scobey	Sulfur Dioxide	Hourly averages
		Suspended particulates	24-hour averages
		Fine particulates	24-hour averages
		Wind speed	Hourly averages
		Wind direction	Hourly averages
		Temperature	Hourly averages
		Sulfation rate	Monthly
2	Scobey - Richardson	Suspended particulates	24-hour averages
		Sulfation rate	Monthly averages
3	Microwave Tower	Sulfation rate	Monthly averages
4	Flaxville	Sulfation rate	Monthly averages
5	TV Tower Hill	Sulfation rate	Monthly averages
6	Scobey-Downtown	Sulfation rate	Monthly averages
7	Four Buttes	Sulfation rate	Monthly averages

METHODS

Sulfur Dioxide	EPA Equivalent Method EQSA-0276-009
Total Suspended	EPA reference Method CFR Title 40 Part 50, Appendix B (State of Montana QA Manual Section 1.1.10 and 1.2.10) 24-hour sample once/6 days, corresponding to the National Air Pollution Surveillance sampling schedule.
Sulfation Rate	Methods of Air Sampling and Analysis, 2nd Edition, Tentative Method of Analysis of the Sulfation Rate of the Atmosphere (Lead Dioxide Plate Method - Turbidimetric Analysis), p. 691.



AMBIENT AIR QUALITY MONITORING (UNITED STATES)

ANNEX 3

METRIC CONVERSIONS

METRIC CONVERSION FACTORS

ac	=	4,047 m^2 = 0.4047 ha
ac-ft	=	1,233.5 m^3 = 1.2335 dam^3
C°	=	1.8 F°
cm	=	0.3937 in.
cm^2	=	0.155 in^2
dam^3	=	1,000 m^3 = 0.8107 ac-ft
ft^3	=	28.3171 x $10^{-3} m^3$
ha	=	10,000 m^2 = 2.471 ac
hm	=	100 m = 328.08 ft
hm^3	=	1 x 10^6 m^3
I.gpm	=	0.0758 L/s
in	=	2.54 cm
kg	=	2.20462 lb = 1.1 x 10^{-3} tons
km	=	0.62137 miles
km^2	=	0.3861 mi^2
L	=	0.3532 ft^3 = 0.21997 I. gal = 0.26420 U.S. gal
L/s	=	0.035 cfs = 13.193 I.gpm = 15.848 U.S. gpm
m	=	3.2808 ft
m^2	=	10.7636 ft^2
m^3	=	1,000 L = 35.3144 ft^3 = 219.97 I. gal = 264.2 U.S. gal
m^3/s	=	35.314 cfs
mm	=	0.00328 ft
tonne	=	1,000 kg = 1.1023 ton (short)
U.S. gpm	=	0.0631 L/s

For Air Samples

ppm = 100 pphm = 1000 X (Molecular Weight of substance/24.45) mg/m^3